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TERRESTRIAL MAGNETISM AND ATMOSPHERIC ELECTRICITY

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Terrestrial Magnetism *and* *Atmospheric Electricity*

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SOME EARLY CONTRIBUTIONS TO THE HISTORY OF GEO-MAGNETISM—V

BY H. D. HARRADON

As the fifth contribution in our series of early documents pertaining to geomagnetism, we are privileged to publish a translation of "Estromento de Sombras" (1537) by Pedro Nunes as reproduced by Hellmann in this Rara Magnetica. This is a section of the extremely rare book "Tratado da Sphera com a Theorica do Sol e da Lua"[1] in which Nunes describes an improvement to Guillen's instrument (brújula de variación) consisting of the addition of a device permitting the observation of the Sun's altitude. He also gives a new method of determining the latitude at any hour of the day.

We are under deep obligation to Dr. J. de Sampaio Ferraz of Rio de Janeiro for the following translation of "Estromento de Sombras." Dr. Sampaio Ferraz also informs us that there is a copy of the rare "Tratado da Sphera com a Theorica do Sol e da Lua" in the Biblioteca Nacional at Rio de Janeiro. His comparison of the two texts showed that the edition in Rio de Janeiro, published at Lisbon in 1537, differs only in a few minor orthographical details from the text as reproduced by Hellmann.

The great difficulties encountered in the interpretation and translation of these early documents, especially those containing descriptions of instruments of which we have no models or other information, is well illustrated by the following quotation from Dr. Sampaio Ferraz' letter of transmittal: "The most difficult part of the excerpt is the one that describes the instrument which, by the way, is completely unknown to us in Brazil, in museums or learned commentaries. The translation made of the descriptive part is, I think, *ipsissimis verbis* of what is written

[1]The full title is: "Tratado da Sphera com a Theorica do Sol e da Lua. E ho primeiro liuro da Geographia de Claudio Ptolemeo Alexādrino. Tirados novamente do Latim em lingoagem pello Doutor Pero Nunes, Cosmographo del Rey Dõ João ho terceiro deste nome nosso Senhor. E acrecẽtados de muitas annotações e figuras per que mais facilmente se podem entender. Item dous tratados que o mesmo Doutor fez sobre a carta de marear. Em os quaes se decrarão todas as principaes duuidas de navegação. Cõ as tauoas do movimento do Sol: e da su declinação. E o regimẽto da altura assi ao meyo dia: como nos outros tempos." (Lisbon, German Galharde, 1537; Folio). The above title may be translated as follows: "Treatise on the sphere with the theory of the Sun and Moon. And the first book of the geography of Claudius Ptolemy of Alexandria. Newly translated from Latin into Portuguese by Doctor Pedro Nunes, Cosmographer of King Don Joao the third of that name, our Master. And enlarged with many notes and figures to render them more intelligible. Also two treatises which the same Doctor wrote regarding the mariner's chart. In which are explained the chief difficulties of navigation. With the tables of the Sun's motion and of its declination. And the ephemeris of altitude at noon as at other times." In the same year a supplement to the above treatise was printed by the same publisher under the title: "Tratado em defensam da carta de marear com o regimento da altura."

in the old Portuguese original, but incomprehensible at that. I consulted several authorities. None of the persons consulted, like myself, can make out the *minor details* (and only these) from the description in the old text." As far as we know this is the only translation of this difficult text in English and we are glad to take this opportunity to place it before the readers of the JOURNAL for consideration and study.

THE SHADOW INSTRUMENT[1]

By PEDRO NUNES

Nothing can be attained in astrology and cosmography without taking for granted the existing knowledge of the subjects. And if we decide to question these fundamentals right from their origins, we would be led to the use of instruments. Therefore, if we wish to know the altitude of the pole, on land and sea, whenever the Sun is visible, we have to fall back on these. For this purpose, I see no better implements that can be taken on board and employed for all altitudes of the pole than the needle, which represents the horizon everywhere, and the astrolabe and globe which represent the universe and the ephemerides of the Sun's declination, common to all altitudes. Taking these things as a basis, together with a mathematical demonstration, I shall describe two methods whereby the altitude of the pole is obtainable, the first one taking for granted that the needle points directly to the pole without swaying either to the northeast or the northwest. The second, however, out at sea, has to allow for such a swing, and, if not, we shall not know the meridian, and by those means which I shall explain, we shall find how much it declines to the northeast or the northwest and by how many degrees it departs from the true meridian. To account for all this we take a circular plate of some solid material of appropriate thickness which weathering will not alter; it may be of brass of good quality as that of the astrolabe and just as plane and smooth, although thicker; we shall graduate the circle into 360 parts and divide it into quarters by inscribing the diameters; in the center we shall place a style perpendicular to the dial-plate, to show in which of the sections the shadows will fall; and in any one of the semi-diameters, at a point equally distant from the center and circumference we shall mark a small circle which we can hollow out just enough to correspond to a similar hole made underneath the plate, where a pointer can be made to move freely like the hands of the ordinary clock, and in the same way we shall make a small circle finished with a mirror on top; but here the needle will be longer and more sensitive, and under the same will run the line which corresponds to the diameter of the large graduated circle over which it must extend without any discrepancy; and as we shall be obliged to direct the needle exactly over that line, to assist the operation we shall paint two black dots on the walls of the needle-case in line with its diameter, so that once the needle is placed in line with the dots, we shall be sure that it coincides with the diameters of the small and large circles. At the back of this plate, facing the center, we shall lodge in the socket hole a strong, heavy, turned rod; in placing the plate on its gimbals together with the needle-case, it must be firm owing to the weight, and strictly

[1]Translated from original by Dr. J. de Sampaio Ferraz of Rio de Janeiro, Brazil.

level; the gimbals should be turned, and with double axles working freely; if despite this carefulness we find that the plate is not level, we should add to its underside the weight necessary to level it perfectly, otherwise the instrument is of no use. If, however, it seems better to suspend the plate in some way to get it leveled, it does not matter; the instrument made for His Highness the Marfil, with turned gimbals and double axles, was so perfect that nothing was wrong with it, and yet its diameter was one palm long. Moreover, we should have a globe perfectly round and large enough for the degrees to be seen clearly, the larger the better. It is unnecessary to have graduated on it more than one great circle which will represent the horizon, and another to represent the meridian, their axis being in the poles of the horizon; it should have a brass meridian, within which the globe will turn on the poles of the horizon. And considering that these instruments are to be employed to locate the Sun on this globe, referred to our zenith as it appears in the sky, at the time we wish to measure the altitude of the pole, we shall perform this in the following manner: We shall place the needle-instrument out in the Sun and turn it around until the needle coincides with its diameter, noting how many degrees the shadow is displaced from the midday line; with the astrolabe we shall find the altitude of the Sun above the horizon. We shall then take the globe which it is not necessary to expose to the Sun, and count on the horizon, starting with its intersection with the meridian, the number of degrees of the shadow; and move the globe until we place the meridian over the number of degrees of the shadow. We shall reckon the degrees of the Sun's altitude as given by the astrolabe, marking a point at the end of the count which point will represent the Sun, and in this way it will be referred to our zenith on the globe as it is in the sky. And if we wish to know the pole's altitude we shall consider all possible cases to do it more clearly; and the first case will be with the Sun in the northern hemisphere which means having north declination; and in the southern quadrants we shall discuss the other cases. The Sun is in the southern quadrants; it follows from the seventh chapter that we are placed between the Sun and the north pole; with the dividers we measure the distance from the Sun to the pole, which will be what remains from ninety less the declination; and having marked the Sun on the globe in the above-mentioned manner, I shall draw a circle with the Sun as center, and over the part of the angle in the zenith which is obtuse, that is, to the north, and where it will intersect the globe's merdian, will be the place of the pole; and subtracting this arc between the zenith and the pole from ninety, we shall obtain the altitude of the pole above the horizon.

SOME EARLY CONTRIBUTIONS TO THE HISTORY OF GEOMAGNETISM—VI

By H. D. Harradon

Gerardus Mercator (Latinized for Gerhard Kremer) was a Flemish mathematician and geographer, born at Rupelmonde in Flanders, March 5, 1512. He studied at Bar-le-Duc and Louvain. In the latter place he established in 1554 his Geographic Institute from which was issued in 1537 the first-known of the important list of maps and globes which brought him fame. In 1552 he moved to Duisberg where in 1568 he published his first map (Nova et aucta orbis terrae descriptio ad usum navigantium accommodata) with meridians and parallels at right angles —the so-called "Mercator's projection." This projection was later improved by Edward Wright and came into general use in the first half of the seventeenth century. Mercator died at Duisberg, December 5, 1594.

In the letter to the Bishop of Arras, a translation of which is printed below, we find for the first time the view expressed and substantiated that the Earth has a magnetic pole. Before this time, it was generally believed that the magnetic needle pointed towards the pole of the heavens or towards the Polar Star. Thus Petrus Peregrinus stated in his Epistola (Part I, Chapter X) "From the poles of the heavens the poles of the Earth receive their Virtue."

Mercator's interest in terrestrial magnetism is shown in the following statement by Hellmann: "Since later Mercator repeatedly expressed his ideas regarding the Earth's magnetic pole, his studies in this connection did not remain without influence on the further development of geomagnetism, as, for example, in the case of Georg Hartmann. In an explanatory document for the various globes which Mercator constructed for Charles the Fifth (1552) he devoted the first four chapters to questions like the following: The existence and position of a magnetic pole; investigation of the latitude and longitude of the magnetic pole; determination of longitude with the magnet; finding the magnetic declination at any place on the Globe—and on his world-chart he drew zero-meridians through the magnetic pole. That Mercator laid great weight on determining the position of this pole is shown by his fine picture, which was executed at the instance of his friend F. Hogenberg of Cologne in which, with a pair of compasses, he fixes the position of the magnetic pole on the globe."

A word may be added in explanation of the remarkable position obtained by Mercator for the North Magnetic Pole. He assumed that the prolongation of the axes of the declination-needles at various points on the Earth's surface would intersect at the magnetic pole. Thus observations of the declination at two points on the Earth would suffice for determining the pole's position. Therefore, assuming that the direction of the compass-needle followed a great circle, he utilized the two stations at his disposal, namely, the Dutch island of Walcheren (9° east) and Danzig (14° east) and found the desired position at longitude 168° west and latitude 79° north—the degrees of longitude being counted from the meridian of the Azores. This point would lie somewhat to the northwest of Bering Strait and in no wise corresponds to the accepted position of the North Magnetic Pole.[1]

[1]See E. Boehn, Zur Geschichte des Erdmagnetismus, pp. 12-13, Hamburg (1910).

GERHARD MERCATOR OF RUPELMONDE TO ANTONIUS PERRENOTUS, MOST VENERABLE BISHOP OF ARRAS, A. D. 1546

Whenever I examined nautical charts, most reverend Bishop, I had to wonder, how it could be that ship-courses, when the distances of the places were exactly measured, at times show their difference of latitude greater than it really is, and at other times on the contrary, smaller, and again frequently hit upon a correct difference of latitude for the places in question. Since this matter caused me anxiety for a long time, because I saw that all nautical charts, by which I was hoping especially to correct geographical errors, would not serve the purpose, I began to investigate carefully the cause of their errors, and found them chiefly to rest on an ignorance of the nature of the magnet.

For the magnet-needle does not always point towards the same point everywhere as shipmasters believe, and Hydrographers pretend, but changes its direction with change of latitude or longitude, for which reason it happens that a given course, for example, which runs east and west now gradually turns more and more towards the south, and so makes the shore-lines appreciably more to the north than they should be, as may be seen along the coast of Africa from the Strait of Gibraltar as far as Carthage, now deviates towards the north and shifts the shore-line by that much more towards the south as is observed by those sailing in the opposite direction from Carthage to Cadiz.

Hydrographers, therefore, should pay more attention to the laws of nautical science, when they delineate coast-lines on the basis of data of ships' courses, otherwise they will not in any way give satisfaction either to themselves or to geographers. In what place, therefore, that point lies, which the magnet so greatly seeks, I shall explain, in general, as far as is now possible, to your Reverence. In the first place, it has been found by experience that at one and the same place, the magnetic needle declines from the true north by the same amount. The point, therefore, can certainly not be in the heavens, because, since every point in the heavens, except the poles, is subject to a rotational motion, the needle, owing to the diurnal rotation of such a point in the heavens, would necessarily wander now this way now that, and hence decline alternately to the east and to the west, which is contrary to experience. On the Earth, therefore, which remains fixed, this point is to be sought. Although the exact difference in longitude between the Zeeland Island of Walcheren and Danzig is known and the intervening coasts have been very accurately depicted from information supplied by mariners, I find Danzig to be indicated further to the north by almost 1° than its true position whence I conclude that the magnetic declination at Danzig is 5° greater from the true north than in Walcheren. At places near Walcheren, I learned that the needle declines 9° to the east from the true north. Hence the magnetic declination is 14° at Danzig. If now, through both places, greatest circles are drawn making an angle with the meridian equal to the observed declination, then it will be found that the point of intersection of these circles will be at about 168° longitude and 79° latitude, and that at this place the magnetic pole must be. Now whenever the needle is in this meridian it will point due north, but if (in the region of Europe) one continues to sail from it toward the east, it will

decline more and more towards the east from the true north, the more the higher latitude, until a quadrant of longitude has been traversed. From that point the declination will diminish in equal degree until the meridian of 168° longitude is attained, whence the needle begins to turn in the opposite direction towards the west until another quadrant of longitude has been passed over. The remaining longitude brings the different directions of the meridian and needle into agreement. However, that this concept of mine corresponds nearly with reality is attested by the map of Canada which I showed your Reverence, for thereon the Hydrographer, whoever he was, had depicted Canada on the basis of voyages made thither, laying out degrees of latitude near Europe, as they really are, and found it necessary to use another latitude-scale for Canada because the declination of the needle from north to west made, on the basis of experience, the latitudes of the places greater; hence he was obliged to displace the numbers of the latitude-degrees farther to the north. Somewhere, therefore, between Canada and Europe, there must exist a meridian common to the world pole and the magnetic pole. And that this (meridian) and the magnetic pole must lie approximately where I said, I could show, considering the longitude of Canada, from the difference of the latitudes attributed to Canada and Europe, if a period of time commensurate with the importance of the matter were at my disposal.

But since there are many other and indeed difficult points to be discussed for the improvement of navigation and of marine charts, it will be enough, I hope, for your Reverence, that I have indicated the fundamentals of that investigation of the magnetic pole. But if at some future time, I shall be free from pressing matters, I have decided to pursue this subject in a suitable manner and solve it. In the meantime, I desire to commend myself to your Reverence and to express my wish for good health and happiness.

Louvain, February 23, 1546.

Always most devoted to your Reverence.

ON THE RADON-CONTENT OF THE ATMOSPHERE AND THE RADIUM-CONTENT OF RIVER-WATER

By Victor F. Hess

In the past two years the author had the opportunity of determining the radon-content of the air in New York and of testing the radium-content of river-water samples taken from the Susquehanna River. War conditions made it necessary to discontinue these measurements, but the results so far obtained, are deemed of sufficient interest to report here.

(I) *Radon-content of the atmosphere*

Measurements of the radon-content of outdoor air in America have been made only in Montreal, by A. S. Eve in 1907-08, and in Chicago, by C. S. Ashman in 1908. These two authors reported an average content of 60 and of 95×10^{-18} curie/cc, respectively.

Determinations of the radon-content of air gave average values between about 80 and 440×10^{-18} curie/cc in Europe (see 1 of "References" at end of paper], 60 to 80×10^{-18} curie/cc in Asia (Philippine Islands), but on Mt. Pauai (near Manila, 2460 meters above sea level) only 19×10^{-18} curie/cc was found while F. Běhounek found values of from 1 to 10×10^{-18} curie/cc in the Arctic Sea; the general average over all oceans, at great distances from the continents measured during the famous cruises of the ship *Carnegie* (Department of Terrestrial Magnetism of the Carnegie Institution of Washington) amounted to only 1.2×10^{-18} curie/cc [2]. These measurements proved definitely that all radon which is found in the atmosphere originates from the continents where it is doubtless given off from the soil, by exhalation of air from the capillaries.

New York with its proximity to the Atlantic Ocean seemed to be a suitable location for further studies; one may expect large variations—air-masses traveling over the continent should acquire more radon than those traveling over sea. The present study is only preliminary. Extensive and well organized measurements of the radon-concentration of air-samples might be helpful even in the meteorological analysis of air-masses.

The apparatus used consisted of two cylindrical ionization-chambers (each of volume 28 liters), which were kept at constant potential of + and − 280 volts, respectively, while their inner electrodes were connected to the same Lindemann electrometer. The ionization-currents produced by local gamma rays and cosmic rays thus were compensated almost completely. This differential method used by the author and his collaborators [3] for various purposes (since 1930) is very suitable for determination of small amounts of radon.

For this particular purpose one of the two chambers is evacuated and air from outdoors admitted through a cotton filter while the other chamber contains air completely free from radon ("aged air," four weeks old). The measurements are made between three and four hours after filling, when the radon in the chamber has reached its equilibrium with the subsequent products, radium A, B, and C.

The capacity of the two chambers with electrometer was 34.4 cm. The whole apparatus was calibrated with a radium standard-solution of 10^{-11} curie, obtained from the National Bureau of Standards. The current produced by 10^{-11} curie in equilibrium with radium A, radium B,

and radium C was found to correspond to 4.5×10^{-4} volt/sec or 5.16×10^{-5} ESU. This value checks very well with calibrations previously made on other ionization-chambers of this size and shape.

The air-samples were taken around noon from a window of the Physics Building at Fordham University, Bronx, New York, about 12 meters above ground, by sticking a long glass tube about one meter out from the window-sill and admitting air through this glass tube and a vacuum-hose into the evacuated chamber. Before the filling-procedure the hose and glass tube were rinsed with outdoor air by sucking with a Hyvac pump.

The Physics Building is surrounded by gardens and parks (Fordham Campus, Bronx Park, Botanical Garden), although some densely populated areas are near-by to the south.

Room-air was also tested occasionally. Stale room-air in the laboratory in winter, with all windows closed, showed, as a rule, a radon-content of 900 to 1000×10^{-18} curie/cc, which is about ten times the mean radon-content of air from outdoors. This is undoubtedly due to exhalation of radon from the walls. The laboratory was kept free from any open preparations of radium and had never been used before for other radioactive measurements. The results for open-air samples are shown in Table 1.

Table 1—*Radon-content of air-samples, Fordham University, New York*

No.	Date	Weather	Curie per cc
	1941		
1	Sep. 23	Warm, rather clear, southerly breeze	166×10^{-18}
2	Oct. 8	Clear, calm	80×10^{-18}
3	Dec. 5	Dry, cold (−2° C), clear	41×10^{-18}
4	15	Dry, clear (+1° C), 2 days after rain	54×10^{-18}
5	16	Clear, humid, mild (+4° C)	100×10^{-18}
6	17	Partly cloudy, hazy, mild (+10° C)	422×10^{-18}
7	18	Overcast, hazy, calm (−1° C)	77×10^{-18}
8	19	Partly cloudy, hazy, calm (+5° C)	123×10^{-18}
9	24	Cloudy after heavy rain, southwest wind (+13° C)	22×10^{-18}
10	26	Overcast, calm (+2° C)	65×10^{-18}
	1942		
11	Jan. 5	Clearing after 3-inch snow, calm (+1° C)	481×10^{-18}
12	7	Partly cloudy, west wind (−7° C)	86×10^{-18}
13	8	Clear, calm (−13° C)	119×10^{-18}
14	12	Hazy, slight north wind (−4° C)	56×10^{-18}
15	14	Hazy, south wind (+2° C)	27×10^{-18}
16	15	Clear, west wind (0° C)	56×10^{-18}
17	19	Drizzle, calm (+10° C)	54×10^{-18}
18	21	Clear, west wind (+4° C)	132×10^{-18}
19	27	Cloudy, southwest wind (+3° C)	144×10^{-18}
20	Apr. 20	Overcast, west wind (+8° C)	114×10^{-18}
21	May 5	Clear	61×10^{-18}
22	6	Cloudy, southwest wind, mild	16×10^{-18}
23	7	Cloudy, windy, mild	13×10^{-18}
24	13	Clear, mild after heavy rain	10×10^{-18}
25	14	Clear, southeast wind, warm	48×10^{-18}
26	17	Fair, southwest wind, sultry	27×10^{-18}
27	18	Cloudy, southwest wind, sultry	21×10^{-18}
	Average value		97×10^{-18}

Discussion—The average of all values, 97×10^{-18} curie/cc, is a little lower than the average over land, computed by the author (130×10^{-18}) from all observations between 1907 and 1924 in continental Europe, England, United States of America, Canada, and Philippine Islands [1, 4]. In view of the small number of observations in New York and the great variations observed at all stations over land, the agreement is reasonably good.

The highest values were found in winter when calm weather, without much snow on the ground, prevailed. The lowest values were found on windy days in spring. This is to be expected since high winds and eddy-currents remove the emanation emerging from the soil into the higher levels of the atmosphere.

It is also to be noted that in spite of the proximity of the Atlantic Ocean the values obtained did not show a very pronounced influence of the wind-direction; this, of course, may be due to the scarcity of occurrence of east winds in New York. On the other hand, the distance of the point of observation from the Ocean (about 20 miles) seems to be sufficient to obliterate to a great extent the oceanic influences on the radon-content of the air near the ground.

The values reported are practically free from influence of any thoron, since the samples were taken 12 meters above ground. Furthermore, the amount of decay-products of thorium is ordinarily negligible in comparison with the radon-products [4].

(II) *The radium-content of river-water*

While engaged with measurements of the concentration of radium in samples from the Susquehanna River mixed with known amounts of radium in very diluted solutions, the author had the opportunity of testing the natural content of radium in river-water by the same differential method that was used for the air-samples.

The river-water samples were taken near Holtwood, Pennsylvania, by the Pennsylvania Water and Power Co., filled in pyrex bottles with ground-glass stoppers and sent to Fordham University in New York.

In order to avoid precipitation of radium by impurities in the river-water, a small amount of hydrochloric acid (40 cc per liter) was added. This was found to be sufficient to prevent precipitation by impurities, such as SO_4-ions, which may always be present in river-water flowing through industrial districts.

The acidulated samples were then filled into carefully cleaned pyrex washing-bottles. After filling, these samples were freed from radon by bubbling a steady stream of inactive nitrogen through the solutions at a well-defined time, for 20 minutes. Use of grease was avoided; all stop-cocks and ground-glass joints were treated with graphite flakes, and carefully tested.

After six to ten days of accumulation of radon in the solutions, the samples were measured. Ordinarily three washing-bottles in series were used (2,100 to 2,400 cc of river-water). The radon accumulated in the solutions was introduced into the previously evacuated ionization-chamber, by passing inactive nitrogen through them for 15 to 20 minutes. Between the washing-bottles and the ionization-chamber a filter of steel-wool, then a filter of cotton, and a drying-tube containing a large quantity

of fresh P_2O_5 was inserted, to avoid disturbance by small droplets (Langevin ions) and deterioration of insulation.

The measurements were begun three to four hours after introduction of the radon. Both chambers were always filled to atmospheric pressure by inactive nitrogen, taken from a steel cylinder where the nitrogen had been stored for weeks.

All chemicals were carefully tested for radium. The observed effect, corrected for background differential ionization-effect of the two chambers, when filled with pure nitrogen, was computed in the usual way, taking into account the known time of accumulation of radon in the bottles.

It was quite surprising to find that the radium-content of the water of the Susquehanna River was extremely variable. The lowest values were about 0.07 to 0.08×10^{-15} gram radium/gram. In most cases the values were between 0.5 and 1.3×10^{-15} gram radium/gram. This would be of the same order of magnitude as the few values reported in the literature [5].

In a few cases, however, much higher values, of about 1×10^{-14} gram radium/gram were observed. It is very doubtful that natural river-water actually could contain so much radium. It seems rather probable that dumping of radioactive waste-products into the river at some industrial plants upstream produced these erratic increases of radium-content.

It was not possible to trace these high values further. Omitting these abnormal values the author tried to find a relationship between the flow of the river-water and the amount of natural radium-content; there was, however, no indication of such a relationship. Uncontaminated river-water should show a higher radium-content when more soil-material is flowing in the water, at high-water mark.

The author wishes to express his thanks to the Pennsylvania Water and Power Company of Baltimore, Maryland, for permission to use the Company's equipment for the experiments described here.

References

[1] V. F. Hess, The electrical conductivity of the atmosphere, p. 107, Constable and Co., London (1928).

[2] O. H. Gish, Atmospheric electricity, Chap. 4, Terrestrial Magnetism and Electricity, Physics of the Earth, VIII, p. 172, McGraw-Hill Co. (1939).

[3] R. Zupancic, Terr. Mag., **39**, 33-46 (1934); H. Roessner, Thesis, Innsbruck (1930).

[4] O. Macek and W. Illing, Beitr. Geophysik, **43**, 388-418 (1935).

[5] St. Meyer and E. Schweidler, Radioaktivitaet, p. 566, B. G. Teubner, Leipzig (1927).

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SUMMARY OF THE YEAR'S WORK, TO JUNE 30, 1943, DEPARTMENT OF TERRESTRIAL MAGNETISM, CARNEGIE INSTITUTION OF WASHINGTON

By J. A. Fleming

The retarding effect of the war on the progress of geophysical research, indicated in last year's summary, continued to influence progress in geomagnetic and geoelectric research during July 1, 1942, to June 30, 1943. Difficulties of communication between countries have increased and scientific investigations have been largely turned toward developments more nearly connected with the requirements of modern warfare. Many established organizations and observatories, however, have found it possible to maintain at least part, if not all, of their programs so that the loss of continuity in accumulating data is not too serious. The war has, unfortunately, prevented the proposed cruises of the British Admiralty magnetic-survey vessel *Research* and the resulting loss of additional observations over the oceans to determine those important changes with the years in the geomagnetic elements is most serious—the more so because of their need in maintaining isomagnetic charts so vital for purposes of navigation, and application in defensive and offensive operations.

It is gratifying that the use in the present emergency is constantly growing of work done by the Department since its initiation in 1904. The past year has emphasized particularly the increasing importance of the observatories. At least 95 per cent of the services of personnel and all of the laboratory, shop, observatory, and building facilities of the Department have been devoted to investigations and solutions of war problems. While this apparently has reduced the continuation of the regular program, many of the results obtained in connection with special war problems are of great peace-time value.

As in previous years during the war, and in conformity with the action of the Trustees, the services of the regular scientific and administrative personnel and the use of facilities have been contributed without charge to the Government. These services during the report-year totaled over 34,400 hours for the scientific staff and over 4,800 for the administrative staff; the corresponding totals for the whole period of the emergency since August, 1940, were 91,000 and 16,600, respectively. In addition the personnel of the Watheroo, Huancayo, and College Observatories were engaged in work proving of great use in the war effort. Twelve of the regular and temporary scientific personnel were on leave of absence in war activities on June 30, 1943, and as stated above fully 95 per cent of the time of the balance of the staff was devoted to war problems. The Department was engaged on ten non-profit contracts with the Army, Navy, and Office of Scientific Research and Development on urgent projects. To assist in the development of these projects additional professional, computing, and clerical assistants were engaged. The maximum number of the staff during the year was 247. Thanks

must again be extended for the generous action of universities and industrial organizations in granting leaves of absence and extending technical advice, as well as to many draft boards in granting deferments of professionally trained men.

Geomagnetic investigations—The study of methods of analyzing and interpreting the geomagnetic field was continued. Data on magnetic anomalies in various parts of the world were compiled for determining their relation to geological formations. An isodynamic world-chart of vertical intensity for epoch 1940 was prepared. Isoporic charts of recent epoch were found regionally to show great changes in form from those prepared by the Department for epoch 1922. A simple method for prediction and extrapolation of certain types of geophysical time-series was evolved.

The average monthly values for all available stations of the solar daily magnetic variation on quiet days, S_q, were derived for the mean of the 12 years from 1922 to 1933. Detailed examination was made of the daily variability of the current-system for S_q with reference to the effect of this variability on the reduction of field-observations to mean of day. As in the case of Huancayo in the Western Hemisphere, a similar though less marked anomalous condition in S_q was found to exist at Manila in the Eastern Hemisphere. The phase of S_q was determined to be practically independent of the amplitude of S_q, apart from seasonal influences.

Daily, weekly, monthly, and annual ranges in the geomagnetic elements in any latitude were derived and the probabilities of ranges of various magnitudes deduced. An extensive study was made of recorded frequencies and magnitudes of geomagnetic fluctuations with durations of ten seconds to several hours. It was found that equipment heretofore generally used at observatories is adequate for detecting fluctuations of durations greater than ten seconds.

The latitude-distribution in amplitude and phase of the yearly changes in the annual means of geomagnetic elements with sunspot-cycle was determined and estimated for each year from 1905 to 1940. A similar derivation was made for all latitudes for the annual variation and post-perturbation. Estimates were made of the induced currents flowing in the oceans due to short-period geomagnetic fluctuations.

General comparison and discussion of geomagnetic and solar phenomena during July 1, 1942, to June 30, 1943, were made of (1) American magnetic character-figure, C_A, (2) relative sunspot-number, R, (3) area, S, of sunspots in the central zone, (4) area, F, of flocculi in the central zone, (5) average total area, P, of prominences referred to central meridian of date, (6) average intensity, C, of the green coronal line referred to the central meridian, and (7) transmission-disturbance figures, TD. Although the solar data are not homogeneous because of differences in observing conditions, the resulting graphs are similar at many times but differ conspicuously in detail. Many instances of nearly simultaneous features are evident, the best being at about November 2, 1942; others are August 23, September 18, November 29, December 26, 1942, and March 23, April 6, April 21, and May 17, 1943. There are, however, as many more cases where magnetic disturbances had no obvious solar cause and cases where solar activity had no magnetic counterpart.

Radio blackouts in polar regions are found to occur during magnetic bays—typical magnetic disturbances of short duration which are preceded and followed by generally undisturbed magnetic conditions. These bays are very pronounced near the auroral zone although their magnetic effects extend to equatorial regions. During every one of 69 significant magnetic bays recorded at College, Alaska, high ionospheric absorption producing partial to complete radio blackouts was observed. The frequency of bays averaged eight a month and they usually occurred between 10^h and 16^h GMT—night at College. They frequently ran in series of two to five days, having a recurrence-interval of close to 24 hours. The similarity of these blackouts to the well-known daylight fade-outs is marked. Both effects appear to be caused by absorption due to intense ionization of the lower ionosphere. The polar blackouts, so prevalent during all magnetic disturbances, must result from particle bombardment (or equivalent) from the Sun.

One type of visual recorder incorporating a sparking device to plot changes in the Earth's field was devised. A long platinum-tipped pointer attached to the magnet-system of the variometer moves over a metallic plate as the suspended magnet deflects in the Earth's field. At intervals of about one minute a spark from the tip of the pointer to the metallic plate makes a record on a sheet continuously moving through the spark-gap. Thus a succession of points burned in the paper makes immediately apparent variation of the Earth's field with time.

In a second method a photoelectric cell is made to follow the light-beam reflected from a mirror rigidly fastened to the suspended magnet of a variometer. A pen attached to, or synchronized with, the photocell gives a record in ink of the deflections of the variometer. Any unbalance of light falling on a twin photocell results in a movement of the photocell to a new position seeking a balance. When equal amounts of light fall on both sections of the photocell, the moving pen stops until a change in magnetic field again causes an unbalance. This instrument has attractive remote-recording possibilities. The soundness of principle was demonstrated by an experimental model and further development is contemplated.

Another type of visual recorder was designed using special photographic paper which leaves a trace, immediately visible through a red filter, of deflections of the light-beam from a standard variometer.

Variometers were designed for measuring short-period geomagnetic fluctuations. Of major interest was the successful construction of the element for measuring vertical intensity, along lines formerly less successfully followed by Watson. New detecting elements for horizontal intensity and declination permit the accurate measurement of geomagnetic fluctuations for periods as short as one-half second. Sudden changes in field such as might give rise to micropulsations not recorded by variometers with slower response can be detected and measured with these instruments. A new variometer of universal pattern for horizontal intensity, vertical intensity, and declination, involving quartz-fiber detecting elements and quartz supports was designed and constructed at the Department. A new type of *portable* magnetograph, embodying novel features developed at the Department, is already being constructed for use in the field as well as at observatories. Such a magnetograph

is greatly needed for securing continuous reliable records over short periods (one or two weeks) for control and reduction of field-observations for which records as obtained at widely spaced observatories have proved insufficient.

Terrestrial electricity—Improvements in the ionization-meters described in last year's summary, were developed during the year and the instruments are now being used in a study of the radioactivity of earth-materials.

A study of manifestations of the electrode-effect in the air-conductivity registered at the Institution's observatories at times when intense electric fields developed, led to inferences about a parameter—denoted the coefficient of combination between small ions and large ions—which appears in the equations for ionic equilibrium. The values of this coefficient heretofore determined by other methods differ so greatly that this approach seemed worth while. The value estimated (5.4×10^{-6}) is within the range of previously determined values. More important, however, is the indication that the value is practically the same for the three observatories Watheroo (Western Australia), Tucson (Arizona), and Huancayo (Peru), which differ considerably in altitude (244, 770, and 3353 meters, respectively), as well as in certain aspects of their environments.

The term columnar resistance is used in some discussions of atmospheric-electric phenomena to denote the effective electrical resistance from end to end of a vertical column of air of unit cross-sectional area. Usually this column is conceived to extend from the Earth's surface to an indefinite height, unless a definite height is specified. This simple concept facilitates the discussion and interpretation of some aspects of atmospheric electricity but it is valid only under certain atmospheric conditions. Additional assumptions are involved in some methods which have been used to estimate columnar resistance, and in some interpretations. A study of these was made to determine their validity in specific cases.

The relative columnar resistance for a given station is the ratio of the columnar resistance there to that for some other station; under certain assumptions it was found equal to the inverse ratio of the values of the vertical electric conduction-current at the respective stations. Evidence of a latitude-effect has been previously presented but this has not generally been taken into account in studies of the relative columnar resistance (generally the resistance for a land station relative to that for the oceans); it was shown that this may lead to anomalous results. In one case the value was only 80 per cent of the corrected value, and without the correction it could not be satisfactorily interpreted. Convenient empirical expressions which accurately describe typical data for the resistance of a column extending from the Earth to a height Z, as a function of Z, were found.

The investigation, reported last year, of the correlation between potential-gradient and wind-velocity at Watheroo was extended this year to include the conductivity and air-earth current. It was found that on smoky days the conductivity is independent of wind for velocities less than about 4½ miles per hour, but for greater velocities it increases with an increase in wind-velocity. This is approximately the inverse of the relation found for potential-gradient, hence the air-earth current undergoes no marked variation with wind-velocity. These results suggest that the smoke from near-by bush-fires is dissipated in a vertical

direction at the higher wind-velocities, thus diminishing the concentration in the lower layers and increasing, more or less correspondingly, that in the higher layers of the air.

On non-smoky days, the air-earth current increased slowly with increase in wind-velocity, particularly for the lower velocities, whereas the conductivity decreased slowly until at velocities greater than about five miles per hour it became more or less constant. This suggests that on non-smoky days there was some smoke in the atmosphere which had come from more distant bush-fires, but that it had been dispersed horizontally by the wind, the total amount in a vertical column decreasing as the wind-velocity increased. At higher velocities the concentration of smoke apparently approached a limit and the conductivity no longer depended upon wind-velocity.

Other investigations bore on the diurnal variation of ionization in the atmosphere, the diurnal variation of air-conductivity at Watheroo, and the diurnal variation in potential-gradient in winter and in summer at Watheroo.

It was estimated from experimental investigations that the particles in exhaled breath—presumably the chief factor in reducing the electrical conductivity of the air in occupied rooms—are much larger than the ordinary nuclei of condensation, being 5×10^4 times that of the large ion of the atmosphere; this fact may account for the failure of some investigators to detect these particles.

Ionosphere—The value of the ionospheric program undertaken by the Department some eight years ago was emphasized by urgent need of particulars regarding the relations of ionospheric variations and disturbances. Many confidential studies for operational application were made and the results from the Watheroo, Huancayo, and College Observatories were advantageously used in these. The Department was asked to establish additional stations and arrangements for these to begin operation within a few months were made—a considerable task as regards equipment, securing and training of observers, and housing.

Nuclear physics—The demands of the emergency for personnel restricted theoretical work in nuclear physics. The need for an operating cyclotron in the region of Washington to meet certain war requirements became more pressing and all efforts of the few members of staff available in laboratory and shop were concentrated to complete the equipment for actual use. Excellent progress was made and preliminary tests indicated satisfactory operation within the year.

Observatory- and field-work—The complete magnetic, auroral, and ionospheric observatory established in collaboration with the University of Alaska at College, Alaska, in July, 1941, was maintained in full operation. Special studies relating to ionospheric problems were made by the Observatory's staff and charts showing graphically the systematic diurnal and seasonal changes occurring in the transmission-characteristics of the ionosphere were prepared.

The extensive geophysical programs at Huancayo and Watheroo magnetic observatories were continued and all resulting data were promptly communicated and made available for emergency use.

Because of commercial requirements it was necessary to end early in 1943 the long series of earth-current records obtained at the Tucson

Magnetic Observatory—a series made possible by cooperation with the American Telephone and Telegraph Company, the Mountain States Telephone and Telegraph Company, and the United States Coast and Geodetic Survey. Cooperation with the Survey in the atmospheric-electric program was continued.

Maintenance of international magnetic standards at the Cheltenham Magnetic Observatory of the United States Coast and Geodetic Survey was effected through the Division of Geomagnetism and Seismology of the Survey.

Table 1—*Annual values of the magnetic elements at the Watheroo and Huancayo magnetic observatories as based on magnetograms for all days, 1941 and 1942*

Year	Declination, *D*	Inclination, *I*	Intensity-components: Horizontal, *H*	Total, *F*	North-south, *X*	East-west, *Y*	Vertical, *Z*	Local magnetic constant, *G*
			Watheroo Magnetic Observatory					
	° ′	° ′	γ	γ	γ	γ	γ	
1941	3 12.3 W	64 25.2 S	24704	57216	24666	−1381	−51608	35723
1942	3 08.2 W	64 24.8 S	24731	57263	24694	−1354	−51647	35756
			Huancayo Magnetic Observatory					
1941	6 50.3 E	2 13.6 N	29471	29494	29262	3509	1146	29477
1942	6 45.3 E	2 12.5 N	29438	29460	29234	3462	1135	29444

Special publications—Six quarto volumes of the series under the general title "Scientific results of cruise VII of the *Carnegie* during 1928-1929, under the command of Captain J. P. Ault" were published by the Institution. These were: "Biology—I: The copepods of the plankton gathered during the last cruise of the *Carnegie*" (237 pages) by Charles B. Wilson; "Biology—II: The oceanic Tintinnoina of the plankton gathered during the last cruise of the *Carnegie*" (163 pages) by Arthur Shackleton Campbell; "Biology—III: Studies in the morphology, taxonomy, and ecology of the Peridiniales" (129 pages) by Herbert W. Graham; "Biology—IV: Biological results of the last cruise of the *Carnegie*" (92 pages), a series of short reports by Herbert W. Graham, Albert William Setchell, Aaron L. Treadwell, W. M. Tattersall, James O. Maloney, Harry G. Barber, Alexander Wetmore, W. M. de Laubenfels, Austin H. Clark, E. A. Chapin, Hoyt S. Hopkins, and Doris M. Cohran; "Meteorology I—Meteorological results of cruise VII of the *Carnegie*, 1928-1929" (168 pages) by Woodrow C. Jacobs and Katherine B. Clarke; and "Meteorology II—Upper-wind observations and results obtained on cruise VII of the *Carnegie*" (94 pages) by Andrew Thomson.

The master-copy and diagrams of results in physical oceanography were half completed by June 30, 1943. This volume is being prepared in two parts: "Oceanography I—A" (150 pages) by J. A. Fleming, H. U. Sverdrup, and F. M. Soule; and "Oceanography I—B" (300 pages) by J. A. Fleming, C. C. Ennis, S. L. Stuart, and W. C. Hendrix. The

first part relates to outline of cruise, descriptions of equipment, and discussions of results in physical oceanography. The second part includes the extended tables and some 254 graphs of observed and reduced data.

The master-copy for "Physical Oceanography II—Marine bottom samples collected in the Pacific Ocean on the last cruise of the *Carnegie*" (190 pages) by Roger Randall Revelle was completed and is awaiting the author's reading of proof before publication. This volume includes also "Radium-content of ocean-bottom sediments" by Charles Snowden Piggot.

Other volumes in the series awaiting publication are "Biology—V" by Herbert W. Graham, and "Chemistry—I" by Herbert W. Graham, E. G. Moberg, and J. P. Ault.

Department of Terrestrial Magnetism,
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LETTERS TO EDITOR

(See also page 245)

PROVISIONAL SUNSPOT-NUMBERS FOR APRIL TO SEPTEMBER, 1943

(Dependent alone on observation at Zürich Observatory)

Day	April	May	June	July	August	September
1	25[a]*	9	9	0	10	0
2	22	13	7	0	17	0
3	22	. .[a]	0	0	8[d]	0
4	30	9*	0	0	8	0
5	24	8	0	0	18	0
6	24[a]	8	0	0	18	0
7	12*	8	0	8[d]	17	*M*19[c]
8	14	8	16[d]	16	27[d]	29
9	19[d]	. .	8*	34	25[a]	31
10	26	7	8	32	18	26
11	31	7[d]	8	28	19	29
12	33	13	8	30	19	22
13	20	14	18	32[b]	19	0
14	20[a]	17	18[a]	21	26[ad]	0
15	28[d]	14	14	19	25	0
16	27	*W*12[c]	18	17	25	0
17	32	37[a]	15*	14	32	0
18	35	47	7	13	41	*M*23[ac]
19	41	34	0	9	53[a]	20
20	37*	20	7	0	49	13
21	38[b]	13	0	0	36	12
22	35	13	0	8	22	. .
23	41	10	*M*10[c]	0	20	7
24	36	10[d]	13	*M*8[c]	9	0
25	34	10*	10	12	0	0
26	22	10	10	12	0	11[d]*
27	20[d]	11	8	17[d]	*M*11[c]	11
28	8	9	7	21	12	13
29	10	9	0	19	10	16*
30	10	9	0	16	7	14
31		10		8	0	
Means..	26.2	13.8	7.3	12.7	19.4	10.2
No. days.	30	29	30	31	31	29

Mean for quarter, April to June, 1943: 15.8 (89 days)
July to September, 1943: 14.2 (91 days)

*Observed at Locarno.
[a]Passage of an average-sized group through the central meridian.
[b]Passage of a large group or spot through the central meridian.
[c]New formation of a group developing into a middle-sized or large center of activity: *E*, on the eastern part of the Sun's disk; *W*, on the western part; *M*, in the central-circle zone.
[d]Entrance of a large or average-sized center of activity on the east limb.

EIDGEN. STERNWARTE,
Zürich, Switzerland

W. BRUNNER

COMMITTEE ON COORDINATION OF COSMIC-RAY INVESTIGATIONS

By J. A. Fleming

This special Committee (consisting of Dr. Walter S. Adams, Dr. Fred E. Wright, and the author) appointed in December, 1932, by Dr. J. C. Merriam, at that time President of the Carnegie Institution of Washington, to consider coordination of possible continued support by the Institution of research on cosmic rays, pursued its activities on a somewhat reduced scale during the year ended June 30, 1943. Although the greater part of the interested personnel was assigned to war-reasearch problems, some progress was made.

There is only a remote possibility that research on cosmic rays may find application to war-research problems. It is essential, nevertheless, in view of past experience, that as far as possible continuity of permanent records obtained with cosmic-ray meters be maintained for future theoretical and statistical investigation. Under the general supervision of the Department of Terrestrial Magnetism the cosmic-ray meters at Cheltenham Magnetic Observatory of the United States Coast and Geodetic Survey, Huancayo Magnetic Observatory (Peru) of the Carnegie Institution of Washington, Amberley Branch of the Christchurch Observatory (New Zealand), National Astronomical Observatory at Tacubaya (Mexico), and Godhavn Observatory (Greenland) of the Danish Meteorological Institute, were kept in operation.

The program of Professor A. H. Compton's group at the University of Chicago included investigations of time- and height-variations of cosmic rays, composition and intensity of cosmic-rays, production of secondary radiation, and properties of the mesotron. Several abstracts of investigations have been published in the *Physical Review*, relating to the evaluation of the lifetime of the mesotron, theory of atmospheric cosmic-ray showers, nature of primary radiation, slow mesotrons in the stratosphere, and reduction of mesotrons and measurements of cascade showers produced by ionizing and non-ionizing radiation.

S. E. Forbush, on leave of absence during the year on a war-research assignment, could spare only the time necessary to consider details of maintenance of the cosmic-ray meters. Miss Isabelle Lange was able to continue the necessary controls of data received. The magnetic-storm effect of March 1, 1942, reported upon last year [Terr. Mag., **47**, 185-186 (1942)] was further confirmed by data received since that report from Godhavn and Christchurch. This appears to be the first definite case of a latitude-effect in cosmic-ray changes occurring during magnetic storms, and also the first case of large sudden increases in cosmic-ray intensity observed simultaneously at several widely separated stations.

Professor Victor F. Hess and associates at Fordham University further confirmed results previously reported on the latitude-effect and found also a longitude-effect. It was concluded that the magnitude of temperature-coefficients of cosmic-ray intensities depends less on geomagnetic latitude than on the distribution of air-masses in the upper atmosphere. The model-C meter used on the *Santa Ana* was removed in

April, 1943, at San Francisco and shipped to Professor Compton at the University of Chicago.

At the Bartol Research Foundation Dr. T. H. Johnson and his colleagues completed the high-pressure cloud-chamber for use under pressures as great as 200 atmospheres. Five hundred photographs at a pressure of 110 atmospheres were taken and a statistical study of these is under way. A statistical analysis of some 40,000 photographs taken with a 24-inch cloud-chamber operating at a pressure of about one atmosphere was begun.

At the New York University Professor S. A. Korff constructed a large boron-trifluoride counter with which the neutron-intensity at sea-level was studied; this counter showed an improvement in sensitivity by a factor of seven over previous determinations. Correlations were established between the cosmic rays at sea-level, when corrected for sea-level barometric pressure, and the fluctuations in the pressure at given levels in the upper atmosphere.

Dr. Robert A. Millikan and his associates and students at the California Institute of Technology continued, as far as urgent war-research demands permitted, the study of the origin of cosmic rays on the hypothesis proposed last year, by tests in Mexico and the United States; confirmatory evidence was found. Improved resolution of the cloud-chamber method of measuring masses of mesotrons and the transformations of energy resulting in their birth and disappearance was obtained. Preliminary measurements were made of the curvature of 135 tracks in a magnetic field of 4500 gauss.

Dr. C. E. Nielsen and Dr. Wilson M, Powell at the University of California found time to determine the maximum values of slow mesotrons through the examination of some 7,000 photographs made on Mount Evans at 14,000 feet and 1800 photographs made at Summit Lake at 12,700 feet, all obtained in July, 1942.

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A NOTE ON FLUCTUATIONS IN THE COSMIC RADIATION OBSERVED IN CONNECTION WITH MAGNETIC STORMS

By S. A. Korff

In recent publications, Forbush and Hess [see 1 of "References" at end of paper] and their collaborators have described the fluctuations in intensity of the cosmic radiation observed during the magnetic storm of March 1, 1942, and have pointed out the existence of two large changes, representing increases of intensity, of short duration, which took place at 14^h GMT, February 28, and at 06^h GMT, March 7, 1942. Duperier [2] has also published a curve showing the main trend of the cosmic-ray intensity. A meter of the Millikan-Neher electroscope-type was in operation at the home of Professor Hilberry at Irvington, New York, during this storm, and its records had been examined for the effect of the magnetic storm. The large changes reported by Forbush and Hess were observed on this record. They had been averaged out in the process of computing the conventional daily means. However, when the hourly intensities were plotted, they became very conspicuous.

At the time of the magnetic storm of September 18, 1941, we had two meters of the Millikan-Neher type in operation at Echo Lake, Colorado, elevation 10,900 feet or about 7 meters of water-equivalent below the top of the atmosphere. The daily means of cosmic-ray intensity showed a drop of about five per cent coincident with the storm. The hourly

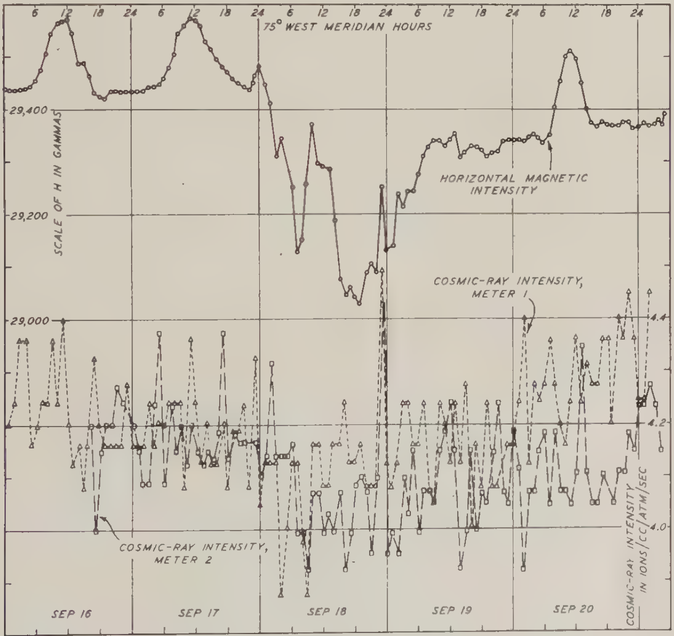

FIG. 1—HOURLY MEANS OF COSMIC-RAY INTENSITY AT ECHO LAKE, COLORADO, AND HORIZONTAL MAGNETIC INTENSITY AT HUANCAYO, PERU, DURING MAGNETIC STORM OF SEPTEMBER 18, 1941 (NOTE LARGE ABRUPT INCREASE IN COSMIC-RAY INTENSITY COINCIDENT WITH AN INCREASE IN MAGNETIC INTENSITY AT 23^h, SEPTEMBER 18, 1941)

means were then plotted and were found to yield the curve shown in Figure 1. On this same diagram, the hourly values for H, the horizontal component of the Earth's magnetic field, are also plotted. These were measured at Huancayo, Peru, and we are indebted to the Department of Terrestrial Magnetism for these data.

A conspicuous change in cosmic-ray intensity occurred at 23^h eastern standard time (EST), September 18, when the ionization as measured by the two meters rose during a one-hour period. One meter recorded an increase of six per cent and the other of seven per cent. The increase is coincident in time with the rise in H at Huancayo. The fact that such an increase was observed on two meters simultaneously and that both meters are in good agreement as to its magnitude, combined with the fact that it was over six times the probable error of the determination, renders it virtually certain that this was a real effect. As the record shows, occasional other fluctuations are observed, but none of this magnitude and practically none are recorded as simultaneous by both meters. Further, the record shows that this was not a "burst" but was an actual increase in the rate of ionization inside a 10-cm shield during this one-hour period. The rise was therefore due to a larger-than-average number of mesotrons passing through the meter. If we take the flux of mesotrons at this elevation under lead to be about three per cm^2 per minute then the increase was of the order of 0.2 mesotrons per cm^2 per minute. This in turn must be due either to a larger number or to more energetic primaries arriving at the top of the atmosphere. The direction of the change, namely an increase, associated with an increase in the strength of the horizontal component of the Earth's magnetic field at the surface is finally also to be noted.

Another large fluctuation in the intensities was observed in our record at 15^h GMT, March 2. At this time the hourly mean rose by 6.5 per cent during a period of one hour. This rise is about six and one-half times the probable error of the determination, and the chance that it should be statistical fluctuation is therefore about 0.00005. This change coincided with a rise in the magnetic intensity at Huancayo as reported by Forbush [1] and may possibly be identified with a quite small variation on the cosmic-ray record he published. However, if two-hour means had been computed, it would have appeared as a change of three per cent, which is only about three times our probable error. The probability of a statistical fluctuation of this magnitude is 0.04, and is therefore to be expected occasionally. Since this fluctuation appears so small on Forbush's record, it may be that this one represented either a local or an accidental effect of some kind. We had only one meter in operation at this time and so have no independent check on this particular fluctuation.

Another large abrupt variation was observed by Duperier [3] on August 14, 1942. Our meters were not in operation on that date, and we are therefore unable to seek this effect on our record. Such large changes, if real, are obviously important. It is suggested that, as a part of any long-period program of cosmic-ray investigation, the average cosmic-ray intensity be determined each hour, in order to reveal other such abrupt fluctuations, should they occur.

References

[1] I. Lange and S. E. Forbush, Terr. Mag., **47**, 185-186, 331-334 (1942), and E. B. Berry and V. F. Hess, Terr. Mag., **47**, 251-256 (1942).
[2] A. Duperier, Nature, **149**, 579-580 (1942).
[3] A. Duperier, Nature, **151**, 308-309 (1943).

New York University,
University Heights, New York, New York, September 1, 1943

MEAN K-INDICES FROM TWENTY-ONE MAGNETIC OBSERVATORIES AND FIVE QUIET AND FIVE DISTURBED DAYS FOR 1942

By H. F. Johnston

To date K-indices have been received at the Department of Terrestrial Magnetism from 21 magnetic observatories for the year 1942. Those contributing were, in order of geomagnetic latitude: College; Sodankylä; Lerwick; Dombås; Meanook; Sitka; Eskdalemuir; Rude Skov; Agincourt; Witteveen; Abinger; Cheltenham; San Fernando; Tucson; San Juan; Honolulu; Huancayo; Hermanus; Watheroo; Toolangi; and Amberley. College, Sodankylä, Toolangi, and Amberley were not included in the list of contributing observatories published [see 1 of "References" at end of paper] in the June 1941 issue of this Journal. The lower limit for a K-index of 9 is 2500γ at College, 1500γ at Sodankylä, 350γ at Toolangi, and 500γ at Amberley.

The mean indices, K_M, for successive three-hour periods of the Greenwich day are given in Table 1 for the year 1942. The agreement of K_M with K_A is very consistent. K_A is a mean index based on K-index reports from the magnetic observatories of the United States Coast and Geodetic Survey located at Cheltenham (Maryland), Tucson (Arizona), Sitka (Alaska), Honolulu (Hawaii), and San Juan (Puerto Rico), and of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington at Watheroo (Western Australia) and Huancayo (Peru). Those K-indices are normalized to represent world-wide conditions. The normalized indices from Cheltenham, Sitka and Watheroo are given double weight. The monthly sums of K_M and K_A agree within one per cent for nine months of the year while for the months of March, July, and November they differ by four per cent.

There was no major disturbance in the year; a K-index of 9 was observed only six times by all observatories (Sodankylä and Rude Skov for the interval 06^h to 09^h, March 1, Sodankylä for 21^h to 24^h, March 1, Sodankylä and Rude Skov for 00^h to 03^h, March 2, College for 15^h to 18^h, March 5). There was only one perfectly calm three-hour interval (03^h to 06^h, June 9). Five Greenwich days had a value for K_M of 1.0 or less for all eight intervals of the day (April 25, June 10, July 4, December 18, and December 30) and only two other 24-hour periods were equally quiet (12^h, January 31, to 12^h, February 1, and from 12^h, February 18, to 12^h, February 19). The only storm of any magnitude lasted from the end of the second interval, March 1 to the same time March 2.

The mean K-indices by months for the Greenwich day are given in Table 2. The average index for the year was 2.17. There is evidence in the Table that, for the cooperating observatories, the greatest activity was near Greenwich noon. Since nine of the stations are near the meridian of Greenwich, it should not be concluded that the diurnal activity of the Earth as a whole is greatest near Greenwich noon. When complete data are collected for the preliminary period 1940-42, more information on the diurnal incidence of geomagnetic activity will be available.

The utilization of K-indices for currently selecting quiet and disturbed days appeared advisable in order to facilitate reductions of magnetic data. At the suggestion of Sir George Simpson, Dr. J. A. Fleming, President of the Association of Terrestrial Magnetism of the International Union of Geodesy and Geophysics, authorized the analysis of all available information on geomagnetic activity to establish the five international quiet and disturbed days for the year 1942.

Table 1--Mean K-indices from twenty-one observatories, 1942

Day	January 1942									February 1942								
	Values K_M								Sum	Values K_M								Sum
1	0.6	1.1	1.1	1.0	0.7	1.0	1.0	1.1	7.6	0.7	0.6	0.7	0.8	2.2	1.7	1.7	1.9	10.3
2	0.9	1.7	2.1	1.8	3.2	3.3	3.7	2.8	19.5	2.0	2.0	3.4	3.4	3.7	3.2	1.6	1.3	20.6
3	3.4	3.4	2.8	2.7	3.2	3.3	2.0	2.5	23.3	2.0	1.9	2.1	0.8	1.0	1.1	1.2	1.0	11.1
4	2.1	4.0	2.5	2.5	4.3	3.5	3.4	4.2	26.5	0.4	0.4	1.6	1.3	1.5	1.1	1.6	1.8	9.7
5	2.5	3.4	3.0	3.6	2.5	3.1	3.8	2.7	24.6	1.1	3.4	2.5	4.0	3.3	3.2	4.2	2.5	24.2
6	1.4	1.9	1.8	2.6	1.7	2.9	3.2	2.9	18.4	3.6	3.6	2.5	4.5	3.7	4.4	4.4	3.8	30.5
7	2.1	2.9	1.2	2.9	2.9	1.4	1.3	1.0	15.7	3.2	2.1	1.7	2.7	1.7	0.9	0.8	1.0	14.1
8	1.1	0.4	0.7	0.2	0.9	0.9	0.3	2.4	6.9	0.8	0.9	1.0	1.3	1.0	1.1	0.7	1.6	8.4
9	1.6	1.4	0.9	0.2	1.6	1.3	2.1	2.0	11.1	1.0	0.8	1.1	1.7	1.6	0.9	0.2	1.0	8.3
10	2.5	1.9	1.7	1.6	2.3	2.9	1.9	2.0	16.8	0.8	0.8	1.3	1.5	3.1	3.2	2.3	2.0	15.0
11	2.2	0.9	2.1	1.7	2.7	1.8	1.9	1.6	14.9	1.7	1.1	1.7	0.9	1.9	2.4	2.8	2.6	15.1
12	1.6	1.1	1.8	1.9	1.5	1.8	2.9	2.1	14.7	1.4	1.2	0.7	0.9	0.6	0.4	0.9	0.7	6.8
13	0.9	0.6	1.2	1.3	2.2	1.9	2.0	1.1	11.2	2.3	1.8	1.2	0.8	1.4	1.0	1.0	0.9	10.4
14	1.2	1.0	0.8	0.7	0.6	0.8	1.4	2.5	9.0	0.3	0.4	1.1	2.2	2.1	2.0	1.4	2.7	12.2
15	1.2	0.9	2.3	1.8	2.9	2.7	1.2	1.8	14.8	2.7	2.6	2.9	2.5	3.1	1.8	3.6	2.0	21.2
16	1.4	1.3	1.7	2.0	2.7	2.7	2.8	4.1	18.7	2.4	2.0	2.4	2.2	2.3	2.0	1.6	2.9	17.8
17	2.9	2.2	3.8	4.0	2.5	2.0	1.6	1.7	20.7	2.7	2.8	1.8	2.2	0.9	0.6	1.4	1.1	13.5
18	3.9	2.9	2.6	2.7	2.3	2.0	2.9	3.8	23.1	1.8	1.6	1.0	0.9	0.5	0.8	0.3	0.4	7.3
19	3.3	4.0	2.7	2.6	1.4	1.4	1.0	2.0	18.4	0.3	0.4	0.6	0.6	1.7	0.9	1.6	1.5	7.6
20	2.3	0.9	1.0	1.5	1.0	1.0	0.9	1.3	9.9	1.2	2.3	1.8	2.0	1.6	2.3	1.9	2.0	15.1
21	0.3	0.4	1.0	0.9	1.0	0.9	1.4	1.1	7.0	2.5	3.0	2.6	1.6	2.3	1.1	1.1	1.2	15.4
22	0.7	1.7	1.5	1.5	3.1	2.4	2.0	2.1	15.0	1.9	1.6	1.5	1.3	1.2	1.7	2.3	2.2	13.7
23	1.7	2.0	1.3	1.2	1.7	1.5	0.8	0.7	10.9	3.3	2.2	1.6	1.2	5.1	5.1	5.3	4.8	28.6
24	0.4	0.3	0.8	1.6	1.4	0.5	0.8	1.7	7.5	5.0	3.1	3.9	3.8	2.5	2.5	1.8	3.0	25.6
25	1.0	0.4	0.7	2.2	1.8	0.9	1.9	1.3	10.2	3.0	1.8	1.4	2.0	2.2	2.6	3.8	4.0	20.8
26	1.1	1.4	1.0	1.5	1.1	0.4	0.6	0.7	7.8	2.6	1.8	1.5	1.2	1.2	0.6	1.4	1.6	11.9
27	0.3	0.3	1.0	1.9	1.1	1.7	1.1	1.2	8.6	0.9	1.0	0.7	1.3	1.0	3.0	3.2	3.0	14.1
28	2.6	2.9	2.6	1.9	2.4	1.8	1.8	1.3	17.3	2.8	2.1	2.0	3.2	5.3	5.3	2.6	2.4	25.7
29	0.7	0.6	0.4	0.5	1.2	1.1	2.0	1.7	8.2									
30	1.4	1.3	1.1	1.0	1.3	2.0	1.5	1.3	10.9									
31	0.5	0.6	1.0	1.3	0.7	0.8	0.5	0.6	6.0									

Day	March 1942									April 1942								
	Values K_M								Sum	Values K_M								Sum
1	2.8	2.2	7.4	7.4	6.4	5.0	6.0	5.7	42.9	2.5	2.9	2.0	1.9	3.0	1.9	1.5	0.8	16.5
2	6.1	5.0	2.5	3.1	3.9	3.4	3.0	1.5	28.5	1.3	2.2	3.0	4.0	4.4	3.8	3.7	3.5	25.9
3	3.1	3.2	3.9	4.7	4.5	5.3	3.2	3.1	31.0	3.3	4.8	3.7	2.9	3.3	2.9	3.6	4.0	28.5
4	3.0	2.7	2.8	3.2	2.3	3.5	3.1	2.3	22.9	2.7	3.7	5.4	5.5	4.2	5.6	5.9	3.0	36.0
5	1.3	3.8	3.7	3.1	3.1	6.3	6.1	5.0	32.4	2.6	2.8	1.4	2.8	3.0	2.1	1.1	1.6	17.4
6	3.9	4.4	3.7	3.9	3.0	2.3	0.7	2.4	24.3	1.6	2.1	0.7	1.2	1.4	0.8	1.0	1.8	10.6
7	2.5	2.0	2.9	3.9	3.1	2.7	3.5	3.5	24.1	0.4	1.0	0.7	0.6	1.5	0.7	0.6	1.4	6.9
8	5.4	4.7	2.8	3.0	2.8	3.4	4.7	3.6	30.4	4.0	4.0	3.8	3.3	3.4	4.0	3.0	2.1	27.6
9	5.6	5.3	3.1	2.9	2.8	3.5	3.1	4.0	30.3	1.9	1.8	2.1	2.6	2.9	2.6	1.6	2.4	17.9
10	2.3	2.9	1.3	3.2	2.5	3.6	3.4	1.6	20.8	0.7	0.8	0.6	0.7	1.0	1.1	1.5	3.3	9.7
11	3.1	3.6	2.2	1.5	0.4	0.4	0.6	1.3	13.1	4.5	4.6	4.9	4.5	4.5	3.7	2.3	2.0	31.0
12	1.4	1.0	1.6	1.5	0.7	0.7	0.5	2.0	9.4	0.6	0.9	0.8	1.9	2.2	2.1	1.7	1.7	11.9
13	3.7	3.4	2.5	4.0	4.4	2.8	2.7	3.9	27.4	2.4	1.3	2.3	2.0	4.4	3.6	3.8	4.4	24.2
14	2.6	2.5	4.3	4.1	3.6	3.4	2.4	3.4	26.3	5.6	3.8	2.6	3.6	2.6	3.2	1.6	1.0	24.0
15	2.5	1.6	1.8	2.1	3.6	2.5	2.6	1.2	17.9	0.7	0.9	1.4	1.2	1.1	0.8	1.6	1.5	9.2
16	1.3	0.5	1.6	1.0	0.9	1.2	1.9	0.9	9.3	2.0	3.2	3.5	2.8	2.3	2.2	3.4	3.8	23.2
17	2.4	2.0	2.6	2.0	0.9	1.1	2.1	2.1	15.2	5.5	5.3	4.5	4.8	4.2	3.9	2.7	2.7	33.6
18	0.4	0.2	2.0	3.1	3.0	3.7	2.9	2.9	18.2	3.4	3.4	3.4	3.8	4.4	4.0	3.9	3.9	30.2
19	2.0	2.2	2.6	2.8	2.8	3.9	3.7	3.9	23.9	3.2	3.1	2.5	3.2	2.7	1.9	2.7	1.8	21.1
20	4.5	3.6	2.9	2.3	1.4	1.6	1.8	0.5	18.6	2.8	1.8	1.0	2.1	3.0	2.9	1.8	1.2	16.6
21	2.4	2.8	3.9	4.1	2.8	3.6	3.1	2.7	25.4	1.0	0.5	0.6	0.5	1.6	1.6	1.7	0.7	8.2
22	3.5	3.1	3.1	3.1	2.4	1.8	2.6	2.5	22.1	1.6	0.8	0.3	0.3	0.6	1.0	0.3	0.4	5.3
23	2.6	2.1	1.0	2.0	2.5	2.9	3.4	2.9	19.4	0.5	2.2	3.2	3.7	4.5	4.4	3.7	3.1	25.3
24	1.7	2.3	2.0	2.6	2.5	2.1	0.6	0.9	14.7	4.0	2.7	2.1	2.4	2.0	1.8	1.4	0.8	17.2
25	1.1	1.3	1.2	2.4	2.3	1.9	0.6	0.6	11.4	0.5	0.5	0.7	0.5	0.8	0.6	0.8	0.9	5.3
26	0.5	0.7	3.3	4.6	4.6	4.9	2.8	1.9	23.3	0.7	1.3	1.1	0.6	0.9	0.8	0.6	0.7	6.7
27	2.0	2.6	0.8	1.3	1.4	1.2	2.2	2.0	13.5	0.8	0.6	1.2	2.1	2.6	3.2	3.6	3.8	17.9
28	1.1	1.0	1.0	0.9	1.3	1.1	1.1	0.6	8.1	5.4	3.1	1.9	2.3	2.6	1.4	1.1	2.3	20.1
29	1.5	3.0	2.1	2.4	4.3	3.2	1.6	1.6	19.7	1.6	1.3	1.4	0.5	0.3	0.6	0.6	2.2	8.5
30	1.0	1.6	2.0	1.5	3.2	3.7	3.0	2.0	18.0	1.0	0.9	1.8	2.2	3.8	3.0	2.9	2.3	17.9
31	0.7	2.0	1.6	2.0	2.2	1.4	2.5	3.3	15.7									

Table 1--Mean K-indices from twenty-one observatories, 1942--continued

Day	May 1942 Values K_M	Sum	June 1942 Values K_M	Sum
1	2.7 3.2 3.4 2.9 2.3 2.1 1.2 1.0	18.8	1.1 1.4 1.0 1.0 1.0 1.1 1.9 0.4	8.9
2	0.7 2.0 2.3 3.1 3.0 3.2 2.2 2.5	19.0	0.2 0.2 0.4 0.6 1.3 0.8 0.8 0.4	4.7
3	2.6 2.5 2.0 2.0 1.6 1.0 1.1 1.7	14.5	0.9 0.7 1.8 2.5 3.2 3.0 2.1 2.4	16.6
4	1.3 1.3 1.5 1.4 2.0 3.5 4.2 3.8	19.0	1.8 0.4 1.1 1.0 0.8 1.0 1.4 1.5	9.0
5	4.8 2.9 2.6 2.7 1.9 1.5 1.3 2.5	20.2	2.0 1.5 2.1 1.7 1.6 2.7 0.7 1.0	13.3
6	1.8 2.6 1.7 1.9 1.5 2.0 1.5 0.5	13.5	1.8 1.7 1.9 2.6 1.6 1.1 0.6 0.9	12.2
7	0.6 1.1 1.3 2.1 1.3 1.0 1.3 1.0	9.7	1.3 1.7 1.2 0.9 1.3 0.5 0.7 0.7	8.3
8	1.1 1.3 0.6 1.1 0.8 1.2 1.5 1.8	9.4	2.0 1.0 1.0 0.6 2.0 1.3 0.8 0.3	9.0
9	1.0 0.6 1.2 1.2 0.8 0.8 0.7 1.0	7.3	0.1 0.0 1.4 0.7 0.8 0.7 0.2 0.9	4.8
10	1.6 1.4 0.8 0.8 2.0 1.8 2.1 3.0	13.5	0.1 0.5 0.5 0.3 0.3 0.9 0.6 0.6	3.8
11	2.8 1.9 1.6 1.1 1.0 1.5 1.0 0.6	11.5	1.6 2.1 2.8 3.1 4.2 4.3 3.9 2.9	24.9
12	0.3 0.3 0.4 0.8 1.1 1.5 1.3 1.1	6.8	3.0 2.4 2.4 3.5 2.3 3.1 2.6 1.9	21.2
13	1.0 1.0 0.8 0.5 0.7 1.0 0.4 1.2	6.6	3.0 2.6 1.8 3.0 2.4 3.5 3.8 3.5	23.6
14	2.0 3.9 4.5 3.3 2.8 2.6 1.8 0.9	21.8	2.9 3.2 3.2 2.5 3.4 2.0 2.3 1.7	21.2
15	1.0 2.1 2.1 2.2 1.6 1.4 2.6 2.0	15.0	1.8 2.0 2.0 1.7 0.9 0.8 1.1 1.2	11.5
16	1.0 1.1 1.2 2.0 1.8 1.5 2.9 1.4	12.9	1.6 1.1 1.3 1.3 1.8 2.1 3.4 1.4	14.0
17	1.9 1.3 1.0 1.3 1.0 1.8 1.9 1.5	11.7	1.5 2.1 2.4 2.7 2.7 2.0 2.0 1.4	16.8
18	2.1 1.0 0.9 2.0 1.0 1.3 1.1 2.0	11.4	3.0 2.3 2.2 2.7 1.4 1.6 0.9 0.5	14.6
19	1.0 1.0 2.0 1.2 0.9 1.1 0.9 0.9	9.0	2.2 1.4 1.7 2.4 4.0 4.3 3.0 3.1	22.1
20	0.3 0.7 1.7 1.7 1.7 3.2 2.3 3.0	14.6	1.9 2.9 2.7 2.6 2.3 2.1 1.6 1.4	17.5
21	3.6 2.1 0.8 1.4 2.4 2.5 1.8 2.0	16.6	1.6 2.5 1.5 0.8 1.6 0.6 0.3 0.4	9.3
22	1.4 1.5 3.9 2.0 1.4 2.4 3.8 2.8	19.2	0.2 0.7 0.9 0.7 1.4 1.2 0.8 0.8	6.7
23	2.7 1.7 1.7 1.5 1.6 2.2 1.7 2.3	15.4	1.0 0.9 1.6 1.9 2.3 2.5 2.3 2.1	14.6
24	1.1 2.0 1.1 0.9 1.4 2.0 1.5 2.2	12.2	3.0 2.6 2.2 1.4 2.2 2.2 1.2 2.0	16.8
25	2.6 0.7 0.5 1.2 1.6 0.8 0.8 0.4	8.6	2.3 2.0 1.9 0.7 1.1 1.8 1.8 1.6	13.2
26	0.4 0.2 0.5 1.0 1.4 0.9 0.7 0.7	5.8	1.2 1.7 1.3 1.2 1.6 2.0 1.8 1.4	12.2
27	0.0 1.1 1.5 3.7 3.2 3.6 3.8 3.5	20.4	1.3 2.0 1.0 0.7 1.3 1.3 0.8 1.1	9.5
28	2.1 4.0 3.9 2.7 2.9 2.0 2.3 2.5	22.4	1.1 1.3 2.7 2.3 3.1 3.4 2.3 2.4	18.6
29	2.0 2.1 1.3 1.6 1.5 1.5 1.4 1.1	12.5	3.2 2.7 2.9 2.0 2.5 2.9 3.1 2.5	21.8
30	2.3 1.3 1.8 1.5 1.0 0.9 1.8 1.1	11.7	3.2 4.0 3.4 2.7 2.3 2.2 2.4 3.0	23.2
31	0.9 1.0 1.4 1.2 0.9 1.3 0.6 0.9	8.2		

Day	July 1942 Values K_M	Sum	August 1942 Values K_M	Sum
1	2.4 3.6 3.7 3.4 2.3 2.3 2.2 1.6	21.5	2.0 2.3 1.0 0.7 1.4 1.1 1.2 1.9	11.6
2	1.0 1.4 1.1 0.8 1.2 1.7 2.1 1.7	11.0	1.1 1.4 1.4 1.3 2.2 2.2 1.9 2.0	13.5
3	1.4 0.7 1.5 1.5 1.6 0.8 0.8 0.4	8.7	2.4 2.1 1.9 1.7 1.7 2.1 1.8 1.9	15.6
4	0.2 0.4 0.7 0.9 0.7 0.5 0.6 0.6	4.6	1.1 1.7 1.5 1.1 0.7 1.2 1.6 1.0	9.9
5	0.6 0.4 1.3 1.5 2.0 1.7 1.6 1.5	10.6	1.7 1.4 0.8 0.7 2.0 1.1 2.0 2.2	11.9
6	1.6 1.2 2.0 1.6 1.8 2.3 1.7 2.2	14.4	1.2 0.8 1.6 2.2 3.1 3.9 2.6 3.0	18.4
7	1.8 0.8 1.6 1.4 2.4 1.9 2.0 2.2	14.1	3.4 2.4 3.9 3.5 2.0 1.9 3.1 3.3	23.5
8	3.3 3.2 3.9 4.7 4.2 3.0 4.0 3.5	29.8	1.5 1.0 1.2 0.9 0.9 0.7 0.7 0.9	7.8
9	3.8 2.3 1.2 1.6 2.0 2.7 2.9 2.7	19.2	0.5 0.8 1.2 2.6 2.9 1.9 1.9 1.6	13.4
10	2.4 2.4 1.7 1.4 1.7 2.2 1.8 3.2	16.8	2.4 2.9 3.2 2.3 3.4 4.5 4.4 3.0	26.1
11	4.2 4.6 5.0 4.5 4.9 4.9 3.9 3.3	35.3	2.1 2.9 3.1 3.1 2.6 1.2 0.7 1.2	16.9
12	2.1 3.1 2.9 4.2 3.0 2.7 3.0 1.9	22.9	2.3 2.4 2.9 3.2 1.9 1.8 2.1 2.0	18.6
13	2.9 2.6 2.2 2.0 1.5 2.2 1.5 1.4	16.3	2.7 1.0 0.6 0.4 0.6 0.4 0.4 1.6	7.7
14	1.8 2.3 2.3 2.8 2.7 3.0 2.8 3.2	20.9	1.8 0.9 1.5 2.2 1.4 0.9 0.4 0.8	9.9
15	2.2 2.6 3.7 3.6 3.5 3.8 4.3 4.3	28.0	0.3 0.2 0.6 1.6 1.5 1.8 3.7 3.2	12.9
16	3.2 2.7 2.8 3.4 2.6 2.3 2.5 3.1	22.6	3.8 4.5 3.1 2.5 2.7 3.2 5.3 4.0	29.1
17	3.4 3.1 2.3 3.2 2.0 2.0 1.6 1.2	18.8	3.5 3.0 2.8 3.4 3.4 3.7 3.0 3.8	26.6
18	1.5 0.9 2.0 2.5 1.0 1.0 1.0 0.9	10.8	2.8 2.5 3.7 4.2 3.9 2.9 3.2 3.6	26.8
19	1.3 0.9 1.1 1.4 2.0 1.4 0.9 1.1	10.1	3.3 2.9 3.9 4.0 3.7 3.6 3.7 4.1	29.2
20	1.2 1.6 3.4 4.4 3.3 2.2 3.1 3.1	22.3	3.6 3.0 2.6 3.7 3.3 2.1 3.1 2.1	23.5
21	4.4 3.1 2.7 2.3 1.8 2.2 2.0 2.3	20.8	2.0 2.6 2.5 2.1 3.1 2.0 2.0 2.2	18.5
22	2.2 1.5 1.4 1.9 2.6 1.4 1.5 1.5	14.0	2.8 3.1 2.4 2.1 1.1 1.8 1.3 3.3	17.9
23	1.7 1.2 2.1 1.0 1.7 2.7 2.8 2.0	15.2	4.1 3.9 2.9 3.2 4.2 5.3 4.5 4.5	32.6
24	2.0 2.7 1.7 1.0 1.5 2.2 2.7 2.2	16.0	3.3 3.5 2.2 2.1 2.5 3.3 4.0 3.6	24.5
25	3.1 3.2 3.1 3.7 4.0 3.0 3.7 3.7	27.5	2.6 4.4 3.9 2.7 2.6 2.3 2.6 3.1	24.2
26	2.0 1.2 1.7 1.0 2.1 1.7 1.9 4.1	15.7	2.5 3.2 2.3 2.1 2.5 2.1 3.1 2.6	20.4
27	4.0 3.3 3.7 3.1 3.8 3.3 3.6 3.7	28.5	3.3 2.2 3.0 3.3 2.7 2.3 1.4 0.4	18.6
28	3.0 3.7 2.7 3.0 2.9 2.4 2.9 2.4	23.0	0.5 1.0 1.9 1.7 0.9 1.0 0.9 1.0	8.9
29	3.4 2.5 2.5 2.2 1.4 1.8 1.5 2.3	17.6	0.3 0.4 1.1 1.1 1.4 1.0 1.6 1.5	8.4
30	3.1 2.2 2.2 3.0 2.6 2.1 2.5 2.0	19.7	0.7 1.0 1.0 1.3 1.8 2.1 3.3 1.0	12.2
31	2.9 2.2 1.5 2.5 2.0 1.8 1.5 1.7	16.1	2.0 1.9 2.1 2.4 3.5 2.2 1.5 1.3	16.9

Table 1--Mean K-indices from twenty-one observatories, 1942--concluded

Day	September 1942 Values K_M		Sum	October 1942 Values K_M		Sum
1	1.4 0.8 1.0 3.0	3.5 3.2 2.7 1.5	17.1	0.6 0.7 0.6 0.4	0.7 1.2 0.9 1.5	6.6
2	2.6 2.6 4.2 2.9	1.8 1.6 2.2 3.5	21.4	2.5 2.0 2.7 4.0	5.5 5.3 5.7 3.5	31.2
3	2.0 1.9 2.3 2.8	1.1 1.2 0.7 0.7	12.7	4.8 5.1 3.9 4.0	4.1 4.5 3.7 3.5	33.6
4	1.4 1.4 1.9 2.6	2.6 2.7 2.0 1.1	15.7	3.2 3.9 3.8 3.7	4.2 4.5 2.9 3.6	29.8
5	1.4 2.7 1.7 2.7	2.2 2.5 2.5 1.8	17.5	3.0 3.7 3.6 3.1	4.0 2.8 2.2 2.4	24.8
6	2.4 2.5 3.6 3.3	4.4 4.0 3.1 4.5	27.8	2.5 1.7 2.1 1.7	0.5 0.7 1.6 2.5	13.3
7	1.8 2.5 2.8 2.4	2.1 3.0 1.5 2.4	18.5	3.7 2.8 2.9 1.8	3.2 2.5 1.7 2.4	21.0
8	2.4 2.4 2.3 2.1	1.7 1.9 1.4 0.9	15.1	2.0 1.8 0.8 1.3	2.0 1.8 3.0 1.7	14.4
9	0.8 1.6 2.4 2.8	1.8 1.2 1.5 0.9	13.0	2.6 2.1 1.8 1.3	1.6 1.4 1.7 0.7	13.2
10	2.0 2.4 2.0 1.8	2.0 1.4 1.2 1.5	14.3	0.6 1.3 2.1 2.2	2.1 1.9 2.0 2.4	14.6
11	1.8 1.9 1.3 2.5	3.7 3.8 4.2 5.0	24.2	1.2 0.8 0.6 2.0	2.5 2.4 4.2 3.0	16.7
12	4.7 4.9 5.3 5.0	3.5 4.2 4.2 3.7	35.5	3.8 3.3 2.7 5.2	4.8 4.0 3.4 3.6	30.8
13	3.5 3.1 3.0 3.4	2.4 3.3 3.6 4.2	26.5	3.8 3.0 2.6 3.2	3.8 5.0 3.5 3.9	28.8
14	4.0 3.4 3.0 3.4	3.0 3.6 4.2 4.5	29.1	3.4 2.9 2.6 3.2	4.4 4.5 4.1 4.3	29.4
15	3.5 4.2 3.5 3.8	3.3 3.6 3.7 2.1	27.7	2.5 4.0 3.5 2.8	3.2 3.0 4.1 4.0	27.1
16	3.1 3.7 2.6 3.0	3.0 3.1 2.7 4.4	25.6	4.2 2.5 2.5 2.8	3.9 3.1 4.0 2.3	25.3
17	3.1 2.5 3.3 4.7	4.0 4.5 3.7 4.1	29.9	2.7 3.4 2.4 1.9	2.1 2.2 2.8 2.5	20.0
18	3.4 3.2 2.9 3.0	2.9 3.7 4.2 3.8	27.1	1.9 2.6 2.7 3.0	2.8 4.0 3.8 3.2	24.0
19	3.5 3.7 3.4 3.8	3.6 3.6 3.0 3.2	27.8	4.4 3.5 3.8 3.7	4.2 4.5 3.0 2.1	29.2
20	2.6 2.6 1.9 4.0	4.6 3.0 3.2 4.0	25.9	3.0 2.6 1.6 3.3	4.0 4.1 2.1 0.8	21.5
21	4.0 3.9 4.0 4.5	4.3 4.2 4.0 2.6	31.5	1.0 1.0 1.6 0.9	2.4 3.2 1.3 1.2	12.6
22	2.4 4.1 2.9 3.7	3.3 3.1 2.0 3.5	25.0	1.1 1.2 0.8 1.4	1.8 0.9 0.8 0.7	8.7
23	2.8 1.7 2.0 2.2	1.2 0.7 1.4 2.2	14.2	0.7 0.6 1.5 1.9	1.6 1.2 1.2 1.0	9.7
24	3.0 1.5 1.7 1.0	1.5 1.2 1.4 1.8	13.1	0.6 0.6 0.6 0.7	1.2 1.2 1.2 1.0	7.1
25	1.8 1.5 0.8 1.2	1.6 1.4 1.2 1.6	11.1	1.8 2.8 3.0 2.6	3.2 1.7 1.4 1.0	17.5
26	1.3 0.8 0.8 1.8	1.6 2.8 1.5 2.1	12.7	1.8 2.4 1.6 0.8	1.0 0.7 2.2 2.7	13.2
27	1.2 1.6 1.9 1.7	2.2 2.0 1.7 2.7	15.0	2.8 1.5 1.5 1.3	1.3 2.1 1.1 1.6	13.2
28	1.9 1.0 0.8 1.3	2.3 1.2 0.9 1.4	10.8	0.5 0.6 0.6 2.6	5.0 6.2 6.0 5.7	27.2
29	1.0 1.0 0.8 1.9	1.8 1.4 1.2 0.8	9.9	4.4 4.6 5.7 5.8	5.1 5.0 5.1 5.0	40.7
30	0.6 0.7 1.5 2.4	1.2 1.0 1.5 1.2	10.1	4.2 4.0 4.3 3.9	4.0 4.9 3.9 3.6	32.8
31				3.8 3.3 3.6 4.2	4.4 3.4 3.6 3.4	29.7

Day	November 1942 Values K_M		Sum	December 1942 Values K_M		Sum
1	2.0 2.3 3.1 3.4	2.5 2.6 1.5 1.4	18.8	1.6 0.5 0.9 0.9	1.5 1.6 3.0 2.5	12.5
2	2.3 2.6 2.4 3.0	2.7 3.6 3.4 1.9	21.9	2.5 0.9 0.6 0.8	0.6 1.1 0.9 1.0	8.4
3	2.0 1.3 1.7 2.1	2.8 2.8 2.5 1.8	17.0	1.5 0.4 0.2 0.4	0.5 1.4 1.0 3.2	8.6
4	0.8 1.7 3.3 3.6	2.2 1.2 2.2 1.9	16.9	2.9 1.8 2.4 1.1	3.4 3.3 1.6 1.6	18.1
5	1.3 0.7 1.3 1.1	1.4 0.8 2.3 3.3	12.2	1.8 1.4 0.7 0.9	1.0 1.5 0.8 0.2	8.3
6	2.9 2.2 0.9 1.3	0.7 2.0 0.9 2.0	12.9	0.3 0.2 0.1 0.9	1.1 0.6 1.7 2.1	7.0
7	1.8 2.2 2.2 2.0	2.8 2.0 1.7 1.8	16.5	1.2 1.1 0.7 2.0	3.0 3.3 2.8 2.9	17.0
8	1.8 2.4 3.0 3.1	3.0 2.3 3.3 2.6	21.5	2.1 1.0 2.3 1.2	2.7 3.1 3.7 3.2	19.3
9	2.3 1.0 0.4 0.8	1.4 1.7 1.7 1.9	11.2	2.9 2.5 1.3 2.2	3.7 4.6 4.2 4.6	26.0
10	1.7 0.8 1.8 1.8	3.9 2.5 2.2 2.6	17.3	4.3 4.0 3.4 2.7	2.1 2.0 2.8 2.9	24.2
11	2.7 2.0 2.2 2.2	3.4 1.5 3.5 2.8	20.3	1.2 3.2 2.0 2.8	3.5 1.6 2.1 3.1	19.5
12	2.2 2.5 2.4 1.3	2.1 1.7 2.0 2.4	16.6	2.9 1.4 2.4 3.2	3.2 2.0 1.4 2.2	18.7
13	2.2 1.6 1.7 2.2	3.7 3.2 2.8 2.7	20.1	1.8 0.2 0.5 0.7	1.0 2.3 1.2 1.1	8.8
14	2.4 2.6 3.0 2.4	1.9 2.6 3.6 3.1	21.6	1.5 1.7 1.7 2.1	2.1 2.5 1.9 1.6	15.1
15	3.5 1.6 0.5 0.8	1.5 2.3 2.5 2.9	15.6	1.3 1.4 0.5 0.6	1.3 1.5 2.4 1.9	10.9
16	3.0 1.1 1.1 1.0	0.5 0.5 1.6 1.5	10.3	1.4 1.9 1.5 1.4	1.3 2.4 1.7 2.2	13.8
17	1.0 1.5 1.4 2.3	2.6 1.7 1.6 2.2	14.3	0.2 0.7 0.9 1.0	0.9 1.1 0.8 1.6	7.2
18	2.7 1.3 2.4 2.4	2.0 2.5 2.9 1.9	18.1	0.8 1.0 0.7 0.6	0.7 0.8 0.3 0.5	5.4
19	0.9 1.3 2.0 2.2	1.2 1.4 1.8 1.8	12.6	0.6 0.6 1.2 1.0	0.4 0.3 0.6 1.2	5.9
20	2.0 2.5 2.0 3.5	2.3 2.6 4.0 2.5	21.4	2.3 1.7 0.9 1.3	0.5 2.8 3.0 3.3	15.8
21	2.0 1.9 2.7 2.6	2.1 1.4 1.9 1.8	16.4	3.6 4.0 3.1 4.0	5.0 4.3 3.4 3.3	30.7
22	0.7 0.2 1.1 1.0	1.0 1.4 1.2 1.3	7.9	3.9 3.5 2.7 3.7	2.7 1.5 2.5 0.9	21.4
23	1.9 1.5 1.6 2.0	3.1 4.0 3.0 5.0	22.1	1.4 2.6 4.1 4.6	4.9 4.7 3.9 2.7	28.9
24	5.3 5.4 4.7 5.3	4.1 3.2 4.6 2.7	35.3	2.2 2.0 3.0 3.4	3.7 3.4 2.5 3.3	23.5
25	3.7 3.4 2.9 3.9	3.2 4.2 3.4 4.5	29.2	3.6 1.7 1.8 2.5	2.8 2.3 2.2 2.5	19.4
26	3.9 4.7 2.6 3.5	4.2 4.0 4.4 3.4	30.7	2.8 3.7 3.3 3.2	3.4 3.7 3.5 3.4	27.0
27	2.0 1.9 2.7 3.9	2.6 1.9 3.3 2.8	21.1	1.7 2.0 1.4 1.1	1.6 1.0 1.2 1.8	11.8
28	1.9 2.2 2.6 3.6	3.8 4.5 3.9 4.0	26.5	1.1 1.7 1.0 0.9	1.9 1.2 1.1 0.8	9.7
29	3.6 2.0 2.0 3.2	3.0 3.3 2.5 2.0	21.6	0.5 0.8 0.4 1.1	1.4 1.7 1.0 1.0	7.9
30	1.2 1.5 2.3 1.5	2.7 1.9 1.8 1.1	14.0	0.7 0.3 0.3 0.2	0.3 0.2 0.8 0.7	3.5
31				1.2 0.3 0.5 0.8	0.3 0.1 0.2 0.5	3.9

TABLE 2—*Mean K-indices by months from twenty-one observatories, 1942*

Month	Mean indices, K_M, for GMT interval								
	00–03	03–06	06–09	09–12	12–15	15–18	18–21	21–24	Mean
Jan.	1.61	1.61	1.62	1.77	1.93	1.80	1.80	1.91	1.76
Feb.	1.94	1.76	1.73	1.89	2.13	2.03	2.03	2.03	1.94
Mar.	2.52	2.56	2.59	2.89	2.76	2.84	2.63	2.45	2.66
Apr.	2.29	2.28	2.15	2.35	2.64	2.41	2.19	2.17	2.31
May	1.64	1.64	1.68	1.74	1.62	1.78	1.73	1.71	1.69
June	1.73	1.72	1.81	1.73	1.96	1.97	1.71	1.51	1.77
July	2.39	2.18	2.31	2.44	2.35	2.23	2.29	2.29	2.31
Aug.	2.18	2.17	2.19	2.24	2.31	2.18	2.35	2.28	2.24
Sep.	2.38	2.39	2.39	2.82	2.61	2.60	2.41	2.59	2.52
Oct.	2.55	2.46	2.39	2.60	3.05	3.03	2.85	2.61	2.69
Nov.	2.26	2.00	2.13	2.43	2.48	2.38	2.60	2.45	2.34
Dec.	1.86	1.62	1.50	1.72	2.02	2.06	1.94	2.06	1.85
Year	2.11	2.03	2.04	2.22	2.32	2.28	2.21	2.17	2.17

To date the selection of five quiet and five disturbed days has depended upon the classification by cooperating observatories of days into three classes, namely, 0 for a quiet day, 1 for an average day, and 2 for an unusually disturbed day [2]. The average of the numbers is computed for each day and it is known as the International Magnetic Character-Figure, C. The five smallest C's give the five quiet days and the five largest (at least in recent years) the five disturbed days.

Thirty observatories made the classification in 1906 and as time went on more and more observatories contributed until 61 observatories supplied tabulations in part of the year 1939. Following the outbreak of the Second World War, tabulations became available from fewer observatories so that selection [3] for the last three months of 1941 depended on 33 observatories.

The days selected by the International Meteorological organization have been used by magnetic observatories in making the reductions. The reductions then had the advantage of being on a uniform basis and their analysis gave comparable data for study of features of the Earth's field over its surface. The method did not insure that the five quietest and the five most disturbed days were automatically selected because of the comparative crudeness of the data. The method suffered from a lack of a definite basis for assigning the numbers, from discontinuity owing to at least one major change in the criterion for classification, and from the idiosyncrasies of collaborators. Over a period of years in the process of selecting the ten quietest days for the five observatories of the United States Coast and Geodetic Survey and the two observatories of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, it was noted that the five international quiet days were often not the quietest and the five international disturbed days occasionally not the most disturbed

Owing to the dislocation of communications due to the war, the five quiet and disturbed days for the first half of 1941 were selected and published [4] using the available reports of magnetic character on a scale of 0, 1, and 2 and the K-indices from 21 observatories. Later a revised list for the same period was published [5], which differed in the case of seven days in the quiet and two in the disturbed. The Astronomer Royal in a

TABLE 3—*Preference for geomagnetically quiet days in 1942*
(Based on data from 30 observatories for C, 7 American for B, and 21 for K_M)

Month	Day, criteria, and order selection	Preference for quiet days according to criterion of activity in second column														
1942 Jan.	Day	1	8	9	13	14	20	21	23	24	25	26	27	29	30	31
	C	2	5	13	14	15	9	4	12	6	10	3	8	7	11	1
	B	8	4	15	13	12	10	3	14	1	11	6	7	2	9	5
	ΣK_M	5	2	14	15	9	10	3	13	4	11	6	8	7	12	1
	Max. K_M	1	14	10	11	15	13	3	9	5	12	4	6	7	8	2
	$\Sigma(K_M^2)$	3	6	15	14	9	10	2	13	5	12	4	8	7	11	1
	Order	3	7	15	14	12	10	2	13	4	11	5	8	6	9	1
Feb.	Day	1	3	4	8	9	12	13	14	16	17	18	19	20	22	26
	C	9	8	6	1	2	3	7	14	15	12	4	5	13	11	10
	B	9	10	6	4	5	2	7	11	14	13	3	1	15	8	12
	ΣK_M	8	7	5	2	3	1	9	13	15	14	6	4	10	11	12
	Max. K_M	8	9	6	3	5	1	7	11	15	13	2	4	14	12	10
	$\Sigma(K_M^2)$	8	9	6	4	5	1	7	11	15	13	2	3	14	12	10
	Order	8	9	6	2	5	1	7	12	15	13	3	4	14	11	10
Mar.	Day	10	11	12	15	16	17	18	22	23	24	25	27	28	30	31
	C	12	10	3	7	2	8	15	13	14	5	4	6	1	11	9
	B	15	8	3	9	2	5	12	14	10	7	4	6	1	13	11
	ΣK_M	14	5	3	10	2	8	12	15	13	7	4	6	1	11	9
	Max. K_M	11	12	3	13	2	5	14	10	9	6	4	7	1	15	8
	$\Sigma(K_M^2)$	14	8	3	10	2	7	13	15	12	6	4	5	1	11	9
	Order	14	8	3	10	2	7	15	11	12	6	4	5	1	13	9
Apr.	Day	1	5	6	7	9	10	12	15	19	20	21	22	25	26	29
	C	15	10	7	4	12	11	8	5	14	13	6	2	3	1	9
	B	14	11	7	3	13	10	8	6	15	12	4	2	1	5	9
	ΣK_M	11	13	9	4	14	8	10	7	15	12	5	1	2	3	6
	Max. K_M	11	12	7	3	10	15	8	4	14	13	6	5	1	2	9
	$\Sigma(K_M^2)$	11	13	8	4	14	9	10	6	15	12	5	2	1	3	7
	Order	12	11	7	4	14	10	9	6	15	13	5	2	1	3	9
May	Day	7	8	9	11	12	13	17	18	19	24	25	26	29	30	31
	C	6	9	2	13	1	3	10	11	7	15	8	4	12	14	5
	B	7	9	4	15	2	5	14	12	8	10	3	1	13	11	6
	ΣK_M	9	8	4	11	3	2	12	10	7	14	6	1	15	13	5
	Max. K_M	15	6	1	11	5	2	7	9	8	12	14	3	10	13	4
	$\Sigma(K_M^2)$	9	7	4	13	3	2	10	11	6	14	8	1	15	12	5
	Order	9	7	4	12	3	2	10	11	6	14	8	1	15	13	5
June	Day	1	2	4	6	7	8	9	10	15	21	22	23	25	26	27
	C	11	1	12	9	5	7	2	3	6	8	4	15	14	13	10
	B	7	2	6	14	5	8	3	1	11	9	4	15	13	12	10
	ΣK_M	6	2	7	12	5	8	3	1	11	9	4	15	14	13	10
	Max. K_M	7	2	6	15	5	8	3	1	9	13	4	14	12	10	11
	$\Sigma(K_M^2)$	5	2	7	13	6	8	3	1	11	10	4	15	14	12	9
	Order	6	2	7	13	5	8	3	1	9	10	4	14	15	12	11
July	Day	2	3	4	5	6	7	10	13	17	18	19	22	23	24	31
	C	4	2	1	5	9	10	14	13	15	3	6	7	11	12	8
	B	2	4	1	5	9	8	14	13	15	7	3	6	10	12	11
	ΣK_M	6	2	1	4	9	8	14	13	15	5	3	7	10	11	12
	Max. K_M	5	2	1	3	6	7	14	12	15	8	4	9	10	11	12
	$\Sigma(K_M^2)$	5	2	1	4	9	8	14	13	15	6	3	7	11	10	13
	Order	5	2	1	4	9	8	14	13	15	6	3	7	10	12	11

TABLE 3—*Preference for geomagnetically quiet days in 1942*—Concluded
(Based on data from 30 observatories for C, 7 American for B, and 21 for K_M)

Month	Day, criteria, and order selection	Preference for quiet days according to criterion of activity in second column														
Aug.	Day	1	2	3	4	5	8	9	11	13	14	15	21	28	29	30
	C	7	8	9	4	10	1	11	15	5	6	14	12	2	3	13
	B	8	9	12	4	6	2	10	15	3	7	13	14	5	1	11
	ΣK_M	7	12	13	5	8	2	11	14	1	6	10	15	4	3	9
	Max. K_M	7	12	13	5	8	2	11	14	1	6	10	15	4	3	9
	$\Sigma(K_M{}^2)$	7	10	12	5	8	1	11	14	4	6	13	15	3	2	9
	Order	7	9	12	5	8	1	11	14	3	6	13	15	4	2	10
Sep.	Day	3	4	5	7	8	9	10	23	24	25	26	27	28	29	30
	C	11	12	13	15	7	6	8	9	5	1	10	14	3	2	4
	B	10	13	14	15	12	11	7	6	8	3	5	9	1	2	4
	ΣK_M	6	13	14	15	12	7	10	9	8	4	5	11	3	1	2
	Max. K_M	10	7	8	14	6	11	5	12	15	1	13	9	3	2	4
	$\Sigma(K_M{}^2)$	7	13	14	15	12	8	9	10	6	3	5	11	4	1	2
	Order	9	13	14	15	11	8	6	10	7	2	5	12	3	1	4
Oct.	Day	1	6	7	8	9	10	17	21	22	23	24	25	26	27	
	C	4	6	12	10	5	9	11	7	1	3	2	13	14	8	
	B	1	5	13	8	10	11	14	9	3	4	2	12	6	7	
	ΣK_M	1	9	14	10	6	11	13	5	3	4	2	12	7	8	
	Max. K_M	2	6	14	10	7	5	13	11	3	4	1	12	8	9	
	$\Sigma(K_M{}^2)$	1	9	14	10	6	11	13	7	3	4	2	12	8	5	
	Order	1	6	14	11	5	7	13	9	3	4	2	12	10	8	
Nov.	Day	5	6	7	9	12	16	17	18	19	21	22	30			
	C	9	5	8	3	11	7	6	12	2	10	1	4			
	B	6	8	9	2	10	3	5	12	4	11	1	7			
	ΣK_M	4	6	10	3	11	2	8	12	5	9	1	7			
	Max. K_M	12	9	8	3	4	11	5	10	2	6	1	7			
	$\Sigma(K_M{}^2)$	5	6	10	3	11	2	8	12	4	9	1	7			
	Order	8	7	10	2	11	4	5	12	3	9	1	6			
Dec.	Day	1	2	3	5	6	13	15	17	18	19	27	28	29	30	31
	C	15	10	13	9	12	7	11	6	3	4	14	8	5	1	2
	B	15	9	11	8	6	10	12	7	3	4	14	13	5	2	1
	ΣK_M	15	9	10	8	5	11	13	6	3	4	14	12	7	1	2
	Max. K_M	14	13	15	7	10	11	12	5	2	4	9	8	6	1	2
	$\Sigma(K_M{}^2)$	15	9	12	8	7	11	13	5	3	4	14	10	6	1	2
	Order	14	9	12	7	8	10	13	5	3	4	15	11	6	1	2

letter dated December 9, 1942, to the President of the Association, indicated the desirability of publishing only a final list in order to avoid duplication of effort in reforming means and remaking the harmonic analysis. He also stated that according to an analysis by Harwood, "The second list produced for quiet days an increase in the monthly range of mean hourly values in 16 out of 36 cases and in the mean extreme daily range of recorded elements in six out of 18 cases."

The following data on geomagnetic activity are now available for the year 1942: International Daily Magnetic Character-Figures C from 30 observatories; daily indices [6], B, based on the actual ranges of K_A from seven American-operated observatories; eight mean indices for each day, K_M, from 21 observatories. To determine upon a suitable basis for selecting quiet and disturbed days, each of the 15 (approximate) quietest days and of the seven (approximate) most-disturbed days each month was examined on the basis of five criteria, namely, $C, B, \Sigma K_M$, Max. K_M, and

Table 4—*Preference for geomagnetically disturbed days in 1942*

(Based on data from 30 observatories for C, 7 American for B, and 21 for K_M)

Month	Day, criteria, and order selection	Preference for disturbed days according to criterion of activity in preceding column								
1942 Jan.	Day	2	3	4	5	17	18	19		
	C	5	6	1	3	2	4	7		
	B	7	3	1	5	2	4	6		
	ΣK_M	6	3	1	2	5	4	7		
	Max. K_M	6	7	1	5	2	4	3		
	$\Sigma(K_M^2)$	6	4	1	2	5	3	7		
	Order	6	5	1	3	2	4	7		
Feb.	Day	2	5	6	15	23	24	25	28	
	C	7	5	3	8	1	4	6	2	
	B	6	4	1	7	2	3	8	5	
	ΣK_M	8	5	1	6	2	4	7	3	
	Max. K_M	7	5	4	8	1	3	6	2	
	$\Sigma(K_M^2)$	7	5	2	8	1	4	6	3	
	Order	7	5	3	8	1	4	6	2	
Mar.	Day	1	2	3	5	8	9	13	26	
	C	1	3	4	2	6	7	8	5	
	B	1	5	4	2	6	7	8	3	
	ΣK_M	1	6	3	2	4	5	7	8	
	Mag. K_M	1	3	6	2	5	4	8	7	
	$\Sigma(K_M^2)$	1	6	3	2	5	4	7	8	
	Order	1	4	3	2	5	6	8	7	
Apr.	Day	2	3	4	11	14	17	18	23	28
	C	8	4	1	5	6	2	7	3	9
	B	5	7	1	3	8	2	4	6	9
	ΣK_M	6	5	1	3	8	2	4	7	9
	Max. K_M	8	6	2	5	1	3	9	7	4
	$\Sigma(K_M^2)$	7	5	1	3	8	2	4	6	9
	Order	8	4	1	3	7	2	5	6	9
May	Day	4	5	14	22	27	28			
	C	2	4	3	6	1	5			
	B	2	6	1	5	3	4			
	ΣK_M	6	4	2	5	3	1			
	Max. K_M	3	1	2	5	6	4			
	$\Sigma(K_M^2)$	5	4	1	6	2	3			
	Order	4	5	1	6	2	3			
June	Day	11	12	13	14	19	29	30		
	C	1	5	3	6	2	4	7		
	B	1	7	2	5	3	4	6		
	ΣK_M	1	6	2	7	4	5	3		
	Max. K_M	1	5	4	6	2	7	3		
	$\Sigma(K_M^2)$	1	7	2	6	4	5	3		
	Order	1	6	2	7	3	5	4		
1942 July	Day	8	11	12	15	20	25	27		
	C	3	1	5	2	4	6	7		
	B	3	1	7	4	6	5	2		
	ΣK_M	2	1	6	4	7	5	3		
	Max. K_M	2	1	5	4	3	6	7		
	$\Sigma(K_M^2)$	2	1	7	4	6	5	3		
	Order	2	1	7	3	5	6	4		
Aug.	Day	10	16	17	18	19	23	24		
	C	3	1	4	5	6	2	7		
	B	5	2	6	4	3	1	7		
	ΣK_M	6	3	5	4	2	1	7		
	Max. K_M	3	2	7	4	5	1	6		
	$\Sigma(K_M^2)$	5	2	6	4	3	1	7		
	Order	5	2	6	4	3	1	7		
Sep.	Day	6	11	12	15	17	20	21		
	C	5	2	1	6	3	7	4		
	B	4	6	1	5	3	7	2		
	ΣK_M	4	7	1	5	3	6	2		
	Max. K_M	5	2	1	7	3	4	6		
	$\Sigma(K_M^2)$	4	7	1	5	3	6	2		
	Order	4	5	1	6	2	7	3		
Oct.	Day	2	3	12	13	28	29	30		
	C	3	4	5	7	2	1	6		
	B	3	4	5	7	2	1	6		
	ΣK_M	4	2	5	6	7	1	3		
	Max. K_M	3	5	4	6	1	2	7		
	$\Sigma(K_M^2)$	4	2	6	7	3	1	5		
	Order	3	4	5	7	2	1	6		
Nov.	Day	2	23	24	25	26	27	28		
	C	6	5	1	2	3	7	4		
	B	7	5	1	3	2	6	4		
	ΣK_M	6	5	1	3	2	7	4		
	Max. K_M	7	2	1	4	3	6	5		
	$\Sigma(K_M^2)$	6	5	1	3	2	7	4		
	Order	7	5	1	3	2	6	4		
Dec.	Day	9	10	21	22	23	24	26		
	C	2	4	1	7	3	6	5		
	B	4	5	1	6	2	7	3		
	ΣK_M	4	5	1	7	2	6	3		
	Max. K_M	3	4	1	5	2	6	7		
	$\Sigma(K_M^2)$	3	5	1	7	2	6	4		
	Order	3	5	1	7	2	6	4		

$\Sigma(K_M^2)$. ΣK_M is the sum of the eight mean indices for each day, Max. K_M is the greatest mean index for that day, and $\Sigma(K_M^2)$ is the sum of the squares of the eight mean indices for the day. $\Sigma(K_M^2)$ was suggested by McNish as an arbitrary system of weighting whereby three-hour intervals with a larger K_M would exert enhanced influence. The quiet days of each month were assigned ranks from 1 to 15 according to their quietness as judged by each of these criteria, and the disturbed days of

each month were assigned ranks from 1 to 7 according to their disturbance as judged by these same criteria. The composite order of preference for each day was determined by the sum of individual preferences on the five criteria. The preferences are given in Table 3 for the quiet days and in Table 4 for the disturbed days. In the case of the quiet days, agreement between selection by the individual criteria and by the composite order are 87 per cent for C, 90 per cent for B, 88 per cent for ΣK_M, 92 per cent for Max. K_M, and 95 per cent for $\Sigma(K_M^2)$. In the case of the disturbed days, the same percentages are 90, 90, 90, 85, and 92.

For purposes of comparison, A. G. McNish and the writer independently selected the quiet and disturbed days from a cursory examination of Watheroo magnetograms. The percentages of agreement with the composite order of preference were 79 and 78 per cent for the quiet days and 83 and 82 per cent for the disturbed days, respectively.

The criterion, $\Sigma(K_M^2)$, for the quiet days, is distinctly in better agreement with the composite order of preference and, for the disturbed days, in slightly better agreement. Table 5 shows the five quiet and disturbed days for the year 1942 based on the composite order of preference.

TABLE 5—*Five internationally selected quiet and disturbed days for 1942*

Month	Quiet					Disturbed				
January	1	21	24	26	31	3	4	5	17	18
February	8	9	12	18	19	5	6	23	24	28
March	12	16	25	27	28	1	2	3	5	8
April	7	21	22	25	26	3	4	11	17	18
May	9	12	13	26	31	4	5	14	27	28
June	2	7	9	10	22	11	13	19	29	30
July	2	3	4	5	19	8	11	15	20	27
August	4	8	13	28	29	10	16	18	19	23
September	25	26	28	29	30	6	11	12	17	21
October	1	9	22	23	24	2	3	12	28	29
November	9	16	17	19	22	23	24	25	26	28
December	17	18	19	30	31	9	10	21	23	26

The President of the Association has decided that the days given in Table 5 shall be designated as the International Days for 1942, and that until the end of the present world conflict, days are to be selected currently, utilizing all available data on geomagnetic activity. The continuation of the cooperative project for supplying K-indices beyond the preliminary period of 1940 to 1942 as recommended by the International Union of Geodesy and Geophysics at its Seventh General Assembly held in Washington in September 1939 is therefore highly recommended.

References

[1] Terr. Mag., **46**, 239-244 (1941).
[2] S. Chapman and J. Bartels, Geomagnetism, 196, Cambridge Press (1940).
[3] Terr. Mag., **48**, 167-169 (1943).
[4] Terr. Mag., **47**, 81 (1942).
[5] Terr. Mag., **47**, 267 (1942).
[6] Terr. Mag., **44**, 441 (1939).

DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON,
Washington 15, D. C., August 30, 1943.

AMERICAN MAGNETIC CHARACTER-FIGURE, C_A, THREE-HOUR-RANGE INDICES, K, AND MEAN K-INDICES, K_A, FOR JULY TO SEPTEMBER, 1943

By H. F. Johnston

Summaries of American *URSI* broadcasts have appeared regularly in this Journal since the issue for December, 1930.

As set forth in this Journal for June, 1937, "The Department of Terrestrial Magnetism and the United States Coast and Geodetic Survey with the cooperation of the United States Army and the United States Navy communication-services and several amateur radio stations have undertaken to supply the American character-figure based upon the

Table 1—*American magnetic character-figure C_A for Greenwich half- and full-days based on reports from Cheltenham, Honolulu, Huancayo, San Juan, Sitka, Tucson, and Watheroo for July to September, 1943*

Day	July			August			September		
	0^h-12^h	12^h-24^h	0^h-24^h	0^h-12^h	12^h-24^h	0^h-24^h	0^h-12^h	12^h-24^h	0^h-24^h
1	0.1	0.0	0.0	0.6	0.6	0.6	1.1	0.8	1.0
2	0.0	0.1	0.0	0.9	0.7	0.8	0.9	0.9	0.9
3	1.1	0.2	0.6	1.0	0.9	0.9	1.4	0.9	1.1
4	0.5	1.1	0.8	0.9	0.8	0.8	1.1	0.5	0.8
5	1.3	1.1	1.2	0.9	0.6	0.8	0.9	0.6	0.8
6	1.3	0.8	1.0	0.4	0.5	0.5	0.6	0.1	0.4
7	0.7	0.6	0.6	0.9	0.6	0.8	0.3	0.1	0.2
8	1.0	0.6	0.8	1.2	1.4	1.3	0.1	1.1	0.6
9	1.1	0.8	1.0	1.2	0.4	0.8	1.0	0.9	1.0
10	0.9	0.5	0.7	0.4	0.0	0.2	1.1	0.8	0.9
11	0.9	0.5	0.7	0.1	0.0	0.0	0.8	0.7	0.8
12	0.9	0.5	0.7	0.0	0.4	0.2	0.8	0.6	0.7
13	0.7	0.6	0.6	1.4	1.3	1.3	0.9	0.6	0.8
14	0.0	0.0	0.0	0.8	1.1	0.9	0.9	0.8	0.9
15	0.2	0.3	0.2	0.5	0.9	0.7	0.4	0.4	0.4
16	0.6	0.2	0.4	1.1	0.7	0.9	0.0	0.5	0.2
17	0.3	0.5	0.4	1.1	0.6	0.9	0.5	0.1	0.3
18	0.6	0.9	0.8	1.1	0.6	0.9	0.2	0.2	0.2
19	0.9	0.5	0.7	0.9	1.0	1.0	0.6	0.1	0.4
20	0.4	0.1	0.3	1.4	0.7	1.1	0.0	0.4	0.2
21	0.6	0.6	0.6	1.0	0.2	0.6	1.0	0.8	0.9
22	0.7	0.6	0.6	0.0	0.0	0.0	0.9	0.6	0.8
23	0.4	0.1	0.2	0.0	0.5	0.2	0.7	0.0	0.4
24	0.1	0.0	0.1	0.9	0.4	0.7	0.1	0.1	0.1
25	0.0	0.0	0.0	0.9	0.6	0.7	0.9	0.2	0.5
26	0.1	0.4	0.2	0.9	0.4	0.6	0.8	1.1	1.0
27	0.4	0.1	0.3	0.1	0.0	0.0	1.1	1.0	1.0
28	0.0	0.0	0.0	0.6	1.3	1.0	1.4	0.9	1.1
29	0.0	0.0	0.0	1.0	1.0	1.0	1.2	1.1	1.2
30	0.9	0.8	0.9	1.5	1.5	1.5	1.5	1.1	1.3
31	0.7	0.5	0.6	1.9	1.5	1.7			
Means	0.5	0.4	0.5	0.8	0.7	0.8	0.8	0.6	0.7

Table 2--Three-hour-range indices, K, July to September 1943

July 1943

	1	2	3	4	5	6	7	8
Si	1131 1111	1132 1112	3583 2222	1243 3544	5565 5444	4556 5533	3434 3433	3456 4332
Ch	2230 0012	1231 1112	3452 2232	2233 4355	6454 3454	6545 3344	4333 2333	4354 3332
Tu	1230 0111	1132 0113	3542 2332	2235 4545	5553 3445	5545 4334	3433 2243	4454 3332
SJ	1120 0000	0121 1112	3432 1221	1224 2353	5432 3234	4444 3233	3332 1322	3343 2221
Ho	1010 0001	0021 1022	1542 1210	0134 3433	5442 3233	4434 3222	2313 1122	3343 2221
Hu	1120 1110	0121 2212	2442 3321	1123 4443	3322 4444	4333 4425	3322 2322	3332 3331
Wa	1231 1111	1221 2123	3342 2211	1233 3653	4544 5455	4545 4444	3333 3433	4345 4342
	9	10	11	12	13	14	15	16
Si	3455 5333	4446 5322	3475 5223	4443 3223	3443 3323	2111 1122	1233 3332	3343 3332
Ch	4554 3343	3444 3322	2444 3324	4555 2333	4433 3333	3011 0120	1233 3123	4424 2233
Tu	4445 2343	4444 3322	2433 3325	4544 2343	4433 2334	3012 0120	1233 4222	4433 1233
SJ	3342 2322	3333 2212	1333 2213	3332 1123	3322 2322	3000 0000	1121 2121	4322 0112
Ho	2244 2233	3334 2101	0332 3122	3333 1121	3232 2122	1001 0000	0112 2013	1222 1110
Hu	2333 4442	2222 3432	1332 3332	2322 2332	3321 3332	2000 1120	1122 2221	3321 2321
Wa	2355 3443	4435 4432	2444 5221	3334 2343	3333 3432	1111 0110	1112 3342	2222 3342
	17	18	19	20	21	22	23	24
Si	3222 2133	2333 4433	3351 2323	3233 3222	3343 3323	2344 3322	2243 3222	2321 1110
Ch	4221 2234	3543 4343	4342 2234	3222 2232	4334 2233	3343 3333	2232 1232	2320 0110
Tu	4332 2234	2434 4443	4441 1334	4222 2222	4333 2323	3343 2233	2243 2323	2321 0100
SJ	3111 2134	3333 3242	4431 1223	3111 1112	2222 2122	3332 1122	1131 0211	1310 0002
Ho	3121 2111	1312 3221	3330 1212	2121 1101	3233 1222	1232 1112	0122 1100	1110 0000
Hu	2011 3323	2323 4433	3331 3322	3212 2221	2232 2331	3222 3322	1121 2321	2311 1210
Wa	3221 2323	1323 4443	4342 2333	2222 2322	3233 3333	3334 4333	3322 2222	1221 1110
	25	26	27	28	29	30	31	
Si	1211 1111	2223 1132	3223 2212	1122 3211	2211 0111	3345 5532	3226 3233	
Ch	2210 0023	2222 2133	4222 2222	1221 0222	3201 0001	3445 3333	3233 2134	
Tu	1310 0112	2322 2223	4232 2232	1322 0112	2211 0002	3444 3333	3334 2133	
SJ	1210 0011	1212 1122	3011 1110	1210 0121	2000 1012	3123 2243	3223 1123	
Ho	0110 0111	2012 0110	2022 1111	0001 1001	1010 0002	2433 3332	2234 2022	
Hu	1200 1111	2211 2232	2121 2321	1211 2220	2101 0102	2432 3422	3222 2332	
Wa	1221 1111	1112 1232	2222 2321	0111 3221	1111 1201	2434 5543	3244 3233	

August 1943

	1	2	3	4	5	6	7	8
Si	3445 5432	3364 4433	4555 5243	3555 5533	3454 4332	3343 3332	3247 6321	3448 8765
Ch	4343 3332	3362 3344	6543 3344	3443 3343	4444 3222	2242 2232	2245 3322	3535 5556
Tu	3343 4433	3363 3334	5544 3244	4434 3343	4444 4223	3343 2243	2246 3312	3645 5645
SJ	2322 2322	3342 2232	5332 2243	3333 2332	3321 2222	2231 1242	2233 2201	3534 5335
Ho	2222 4321	2353 2222	3343 3222	2332 3222	3333 3110	1233 2131	2225 3201	3434 3533
Hu	2221 2432	3331 4342	4332 3332	3312 3442	3321 4332	2222 2332	2233 3311	3433 3534
Wa	2333 5443	3243 4443	3444 4342	3334 5433	3444 4432	1233 3242	2335 4511	2435 6655
	9	10	11	12	13	14	15	16
Si	7863 4422	4432 3112	2232 2122	2232 2223	4668 7435	3545 6333	3342 3333	3455 5433
Ch	7633 2224	4322 0123	2232 1132	3230 1035	4555 4455	5434 3445	4332 3444	4465 3433
Tu	6642 3223	4422 1123	2232 1122	2331 2235	4555 4445	4444 3444	3332 3343	4465 3333
SJ	5420 1111	3310 0011	2221 0021	1220 0123	3444 3335	3222 2333	3321 2333	3444 2222
Ho	4331 1002	2321 0001	0021 0012	0120 0213	2544 3224	2223 2223	2232 1222	3355 2222
Hu	4411 2321	3211 2121	2211 2121	2211 2222	3433 5544	3222 4433	3221 4433	3343 3432
Wa	5343 4332	3223 2212	1221 2121	2221 1224	3546 5456	3235 4545	3332 4453	4345 4433
	17	18	19	20	21	22	23	24
Si	4584 3233	3459 6323	2357 7334	4668 4333	3543 4222	2121 3111	2211 3223	4552 2322
Ch	6552 3244	4445 3333	1345 2445	6545 3344	5433 2222	3220 1122	2211 3144	4542 2333
Tu	6553 2334	3456 4323	2345 4434	5545 3234	4444 2213	2220 2111	1322 2334	4542 3333
SJ	4432 1123	3335 2221	1243 1434	5443 2233	4432 1111	1210 1010	1200 1123	4541 1222
Ho	4443 1211	3345 3302	1243 3322	5445 4223	3333 2111	1000 0011	0111 1123	2442 2212
Hu	4321 3322	3334 5322	1233 3533	4443 4332	4432 3322	1111 2220	2211 3331	4421 3421
Wa	4444 2533	3347 5432	1245 4544	4455 4343	3334 4221	1111 2221	1111 2213	2542 2422
	25	26	27	28	29	30	31	
Si	3453 3433	3474 3222	1321 1122	1326 8534	4456 6632	4659 8645	7898 9744	
Ch	5542 2333	4453 2232	1311 0112	2323 5445	5453 4442	6655 5557	7866 6554	
Tu	5542 2324	4452 2233	2311 1111	2335 5535	5554 4442	5655 5555	7866 5554	
SJ	3421 1221	3342 1221	1300 0111	2223 4424	5432 3441	5543 4556	6655 4343	
Ho	4332 3211	2342 2120	0000 0111	2335 4334	3343 3331	3444 3344	4665 5542	
Hu	2311 3432	3331 3331	1200 1221	2324 6633	4423 4441	5433 4544	6544 5543	
Wa	3322 3433	2343 2331	1111 1121	1334 5534	3335 6542	4645 5545	5676 7643	

Table 2--Three-hour-range indices, K, July to September 1943--concluded

September 1943

	1	2	3	4	5	6	7	8
Si	5467 7542	4456 7433	4678 7533	3677 4322	4446 5333	2454 3221	2333 3212	2133 3453
Ch	6543 3433	5444 4344	5554 4345	4454 3332	5533 3333	4332 2221	3321 1133	2132 2354
Tu	5443 4443	5544 4344	4555 4334	3554 2222	5544 2343	3443 2121	3332 2123	2223 2553
SJ	5333 2322	4322 3144	4443 2334	3443 2210	4422 1223	3321 1230	2211 0211	0022 1453
Ho	4343 3321	3334 4223	3454 2224	2344 2200	2433 1233	1233 1021	2112 1111	1122 1332
Hu	4323 3442	4322 4333	4423 4433	3333 3421	3322 3332	2201 2330	1111 2221	2222 3453
Wa	4444 5432	4335 5345	3445 4434	2445 4342	3334 3432	2334 1221	1122 3222	1122 2553
	9	10	11	12	13	14	15	16
Si	6445 4334	5447 5423	4543 4333	3225 4333	5535 5433	3335 5233	3342 2321	1123 2321
Ch	5534 3345	6443 3434	5432 3334	4234 2234	5444 2332	4434 3235	4332 2234	2211 2333
Tu	5544 4344	5545 3423	5532 2324	4235 2343	5534 3343	4445 3234	3332 2323	3222 2423
SJ	4422 2224	5333 2322	4421 2214	4313 0132	4432 1333	3324 3133	3321 0223	1210 1322
Ho	5434 1223	3334 2212	2321 2112	2014 1222	3323 3232	3333 2223	2232 1211	1102 1112
Hu	4312 5433	4322 4422	3411 3423	4222 2332	3322 3432	2323 3432	3210 2322	1110 3432
Wa	4444 4433	4435 4333	3332 5344	2225 3442	4434 3432	3334 4243	2332 3333	1221 3432
	17	18	19	20	21	22	23	24
Si	1441 1222	2312 1123	3444 2111	1210 2222	3256 5333	3453 4422	3444 2111	2332 1112
Ch	2441 1124	2311 1124	3433 2222	0310 3123	4344 3343	5542 3332	4443 1222	3220 1022
Tu	2442 1123	2312 1024	4433 2122	1221 2212	3344 3344	3542 3322	4444 1222	3220 1113
SJ	1321 0123	1300 0035	4331 1121	0211 2212	3333 2143	4520 2221	3322 0111	3110 0002
Ho	0231 0112	0101 0013	2213 1010	0011 2111	2234 3112	1342 2201	2343 1001	0110 1002
Hu	3321 2222	2210 1122	3322 3321	0211 5422	3333 4432	3422 4421	2321 2211	3112 2211
Wa	1321 3223	2212 1124	3333 3232	1121 2213	3245 4343	3333 4422	2232 2211	2221 1223
	25	26	27	28	29	30		
Si	2344 3111	1374 7533	4456 5443	6658 7433	4678 8553	5669 6434		
Ch	2453 2221	2454 5443	5544 3254	6543 3234	4645 5345	6656 4345		
Tu	2553 3211	2465 5544	5544 3253	5544 4335	5645 5344	5655 4435		
SJ	1432 2101	2333 4344	4334 3243	5433 3124	3433 3244	4533 2235		
Ho	1443 3101	1354 5332	4343 2233	4443 3313	2435 4333	3544 3224		
Hu	2432 3321	1222 5442	3222 4343	5422 3433	3323 4343	4423 4444		
Wa	1553 3311	1344 6543	3225 4343	4444 5544	3355 6554	3346 4445		

Table 3--Weighted average of reduced three-hour-range indices, July to September 1943

Day	July 1943									August 1943									September 1943								
	Values K_A								Sum	Values K_A								Sum	Values K_A								Sum
1	1^x	1^x	2^x	0^x	0^x	0^x	0^x	1	8^x	2^x	2^x	3	3	3	3^x	3	2	22^x	5	4	4	3^x	4	4	3	2^x	30
2	1	1	2^x	1^x	1	1	1^x	2	11^x	3	2^x	4^x	2^x	3	3	3^x	3	25	4^x	3^x	3	4	4^x	3	3^x	4	30
3	2^x	4	4^x	2^x	2	2	2	1^x	21	4^x	4	4	3^x	3^x	2^x	4	3	29	4	4^x	4^x	5	4	3^x	3	4	32^x
4	1^x	1^x	2^x	3^x	3	4^x	4^x	4	25	3	3^x	3	3^x	3^x	3^x	3^x	2^x	26	3	4	4^x	4^x	3	3	2	1^x	25^x
5	5	4	4	3^x	3^x	3^x	4^x	4^x	32^x	3^x	3^x	3^x	3	3^x	2^x	2^x	2	24	4	4	3	3^x	3	3	3	3	26^x
6	4^x	4	4	4^x	3^x	3^x	3^x	3^x	31	2	2	3	2^x	2	2	3^x	2	19	2^x	3	3	2^x	2	2	2	1	18
7	3	3	2^x	3	2	3	3	3	22^x	2	2	3	5	3^x	3	1	1	20^x	2	2	2	2	2	1^x	1^x	2	15
8	3^x	3	4	4	3	3	3	2	25^x	3	4	3	5	5	5^x	4^x	5	35	1^x	1^x	2^x	2	2	4	5	3^x	22
9	3	3	4^x	4	3	3^x	3^x	3	27^x	5^x	5	3	2	2^x	2	2	2	24	5	4	3	3^x	3^x	3^x	3	4	29^x
10	3^x	3	3	4	3	3	2	2	23^x	3^x	2^x	2	2	1	1	1^x	2	15^x	5	4	3	4	3^x	3^x	2	3	28
11	2	3^x	4	3^x	3^x	2^x	2	2^x	23^x	1^x	1^x	2	1^x	1	0^x	2	1^x	11^x	4	4	2^x	2	3	3	2^x	3^x	24^x
12	3^x	3^x	3^x	3^x	2	2^x	3	2^x	24	2	2	2	1	1	1^x	2	3^x	15	3^x	2	2^x	4	2^x	3	3	3	23^x
13	3^x	3	2^x	2^x	2^x	3	2^x	2^x	22	3^x	4^x	4^x	5^x	4^x	4	4	5	35^x	4^x	4	3	3^x	3	3^x	3	2^x	27
14	2	0^x	0^x	1	0^x	0^x	1^x	0^x	7	3^x	3	2^x	3^x	3^x	4	3^x	4	27^x	3^x	3^x	3	4	3^x	2^x	3	3^x	26^x
15	1	1^x	2	2^x	2^x	2	2^x	2	16	3	2^x	2^x	2	3	3^x	3^x	3	23	3	3	3	1^x	2	3	2	2^x	20
16	3	2^x	2^x	2^x	2	2^x	3	2	20	3^x	3	4^x	4^x	3	3^x	3	2^x	27^x	1^x	2	1^x	1^x	2^x	3^x	2	2	16^x
17	3	1^x	2	1^x	2	2	2^x	3	17^x	4^x	4	4^x	3	2	2^x	3	3	26^x	1^x	3^x	3	1^x	1^x	1^x	1^x	3	17
18	2	3	2^x	3	3^x	3^x	3^x	2^x	23^x	3	3	4	6^x	4	3	2	2^x	28	1^x	2^x	1	1^x	1	1	2	4	14^x
19	3^x	3	3^x	1^x	1^x	2^x	2^x	3	21	1^x	2^x	4	4^x	3^x	4	3^x	4	27^x	3	3^x	3	3	2^x	1^x	1^x	1^x	19^x
20	3	1^x	2	2	2	2	2	1^x	16	4^x	4^x	4^x	5	3^x	2^x	3^x	3	31	0^x	2	1^x	0^x	2^x	2	1^x	2^x	13
21	3	2^x	3	3	2^x	2^x	2^x	2^x	21^x	3^x	3^x	3	3	2^x	2	1^x	2	21	3	2^x	3^x	4	3^x	3	3^x	3	26
22	2^x	2^x	3	3	2^x	2^x	2^x	2^x	21	1^x	1	1^x	0^x	1^x	1	1^x	1	9^x	3^x	4	3^x	2	3	3^x	2	1^x	23
23	2	1^x	2^x	2	1^x	2	2	1^x	15	1^x	1^x	1	1	2	2	2^x	3	14^x	3	3	3	2^x	1^x	1^x	1	1^x	17
24	1^x	2^x	1^x	1	0^x	1	0^x	0	8^x	3^x	4^x	4	2	2	3	2	2^x	23^x	2^x	2	2	1	1	1	1	2^x	13
25	1	2	1	0^x	0^x	0^x	1	1^x	8	3^x	3^x	3	2	2^x	3	2^x	2^x	22^x	1^x	4	4	3	3	2	1	1	19^x
26	1^x	1^x	1^x	2	1^x	1^x	2^x	2	14	3	3	4^x	2^x	2	2	2^x	1^x	21	1^x	3	4^x	4	5	4^x	3^x	3	29
27	3	1^x	2	2	1^x	2	1^x	1^x	15	1	2	1	1	0^x	1	1^x	1^x	9^x	4	3^x	3	4	3^x	3	4^x	3^x	29
28	1	1^x	1^x	1^x	1^x	1^x	1^x	1	11	1^x	3	2^x	4	5^x	4^x	3	4^x	28^x	5	4^x	3^x	4	4	3^x	2^x	4	31
29	2	1	0^x	1	0^x	0^x	0^x	1^x	7^x	4	3^x	3^x	3^x	4^x	4^x	4	2	29^x	3^x	4^x	4	5	5	4	4^x	4	34^x
30	2^x	3^x	3	4	3^x	3^x	3^x	2^x	26	4^x	5	4	5^x	5	5	4^x	5^x	39	4^x	4^x	4	6	3^x	3^x	3^x	5	34^x
31	3	2	2^x	3^x	2	1^x	3	3	20^x	6	7	6^x	6	6^x	5^x	4^x	3^x	45^x									

reports of the seven American-operated observatories—those of the Department of Terrestrial Magnetism at Huancayo in Peru and at Watheroo in Western Australia, and those of the United States Coast and Geodetic Survey at Cheltenham (Maryland), Honolulu (Hawaii), San Juan (Puerto Rico), Sitka (Alaska), and Tucson (Arizona)." This character-figure is being designated C_A, and its values for the first twelve, the second twelve, and all twenty-four hours of each Greenwich day for July to September 1943, are given in Table 1.

The three-hour-range indices, K, have been compiled since April 6, 1940, for each of the seven American-operated observatories. The eight indices for each day give geomagnetic activity for three-hour periods successively during the Greenwich day. The indices range from "zero" very quiet to "nine" extremely disturbed. The K-indices for Sitka (Si), Cheltenham (Ch), Tucson (Tu), San Juan (SJ), Honolulu (Ho), Huancayo (Hu), and Watheroo (Wa), for July to September 1943, are given in Table 2. Interpolated indices are shown thus, $\ddot{3}$.

In the manner set forth in the JOURNAL for September, 1940, the indices are standardized into reduced indices K_r to eliminate local variations. A weighted mean index K_A, is derived from the reduced indices. The reduced indices from Si, Ch, and Wa are given double weight and those from Tu, SJ, Ho, and Hu are given single weight. The weighted indices, K_A, for July to September, 1943, are given in Table 3. A superior cross ($^\times$) following an index-number denotes a half-unit, thus $5^\times = 5.5$, etc.

DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON,
Washington 15, D. C., October 30, 1943

REVIEWS AND ABSTRACTS

E. F. Herroun and A. F. Hallimond: *Laboratory experiments on the magnetization of rocks.* Proc. Phys. Soc., **55**, No. 309, 215-221 (1943).

The study of the general magnetic field of the Earth, and of the local variations produced by the presence of various deposits of ores, has been of the greatest importance not only for theoretical reasons, but also for the practical business of geological surveying and prospecting. However, very much more work needs to be done on the possible ways in which various types of rocks may have acquired their magnetic fields before many of the details of rock-formation can be filled in, and a complete interpretation of the results of magnetic surveys obtained.

It is for these reasons that the recently published results of experiments on the magnetization of rocks by Herroun and Hallimond [Proc. Phys. Soc., **55**, 215-221 (1943)] are of importance. Their experiments were carried out on a number of rock-samples, some collected from areas which have already been covered by magnetic field-surveys and whose original locations ranged from various parts of Scotland down to Leicestershire. It is known that many of the observed magnetic anomalies can be explained if it is assumed that the magnetic field of rock has been partly induced by the present field of the Earth, and is partly due to a magnetic field acquired earlier. The object of these experiments was to see what intensity of magnetization could be induced in the rock-samples under a variety of conditions.

The first set of experiments was intended to study the magnetism acquired by a rock-sample when cooling from a red heat in the Earth's magnetic field. It is known that heating to redness destroys the magnetism of practically all rocks, but if, during the process of cooling, the rock is subjected to an external magnetic field, such as that of the Earth, a certain order will be introduced into the molecular arrangement of the sample, and will result in a permanent magnetization.

Cubes of one and a quarter inches in size were cut from the rock-samples. These were then placed in an earthenware pot and surrounded with iron ore. The object of this was to protect the cubes from the oxidizing action of the air, and to simulate natural conditions as far as possible. The cube was placed level, and one edge was pointed in the direction of magnetic north. The pot and its contents were next heated in an electric furnace having no iron fittings, and after about an hour at redness allowed to cool. The protection of the specimen from oxidization was not complete, and there was some change due to the action of the steam liberated by the specimen itself, but this could hardly be avoided. When the specimens had cooled their magnetization was measured and it was found that this had greatly increased. Moreover, the specimens afterwards retained their magnetic properties, and even after four months showed no appreciable change.

The behavior of specimens in the cold was quite different. Here a very large field was needed to induce the same magnetic intensity, and even then it was not permanent but died away slowly. Weak fields had no effect at all; and it was interesting that a field as weak as that of the Earth produced no magnetization, so that it is clear that samples of magnetic rock can be moved on the Earth's surface without danger of altering their magnetic properties. Higher fields than the minimum produced rapidly increasing magnetization; but it was found that if a specimen once magnetized in this way was then subjected to a second field at right-angles to the first, the two effects did not reinforce one another, and that the second magnetization actually produced a reduction in the magnetization which had been induced first.

Comparing these results with the observations of rocks which are naturally magnetized, the authors found that certain rocks have a natural magnetization as great as that which would be produced by cooling in the Earth's field. It therefore seems clear that such rocks must have become magnetized during a cooling process, for to produce the same result in the cold would require, allowing for the decay of magnetization induced in this way, a field between ten and thirty times as great as the present field of the Earth. An additional argument for this is that if the magnetization had been produced by some magnetic field outside the Earth, this hypothetical field must have acted for only a very short time; for otherwise the rotation of the Earth on its axis would have changed the direction of the magnetizing field, which, as the experimental results showed, would not have increased the magnetization but have tended to destroy the magnetization produced initially. [Reprinted from *Discovery*, **4**, No. 6, 163-164 (1943), with permission of the Editors.]

REMARKABLE AURORAL FORMS, MEANOOK OBSERVATORY, POLAR YEAR, 1932-33

By E. H. Vestine

Störmer[1] has discussed various remarkable auroral forms noted in Southern Norway during the course of many years of auroral observations. Among these were several examples of long, feeble homogeneous arcs, of uniform narrow and sharply-defined width, noted at heights about 200 km above the Earth—nearly twice the height of the usual homogeneous arcs. An arc of this kind was noted by Störmer on February 22, 1911. On September 29, 1930, a similar arc was noted with an average measured height of lower border of 195 km, and of upper border 232 km. Corresponding heights on March 10, 1932, were 192 km and 227 km, and on December 9, 1933, 197 km and 216 km, respectively. He also mentions earlier observations of similar arcs noted in Europe on October 6, 1847, February 15, 1858, February 15, 1865, and February 12, 1867.

At the Meanook Magnetic Observatory there were noted February to April, 1933, five definite instances of such homogeneous arcs, with a possible sixth, as follows:

February 26, 1933

The first instance noted of a homogeneous auroral arc of the form described by Störmer appeared, and was but briefly described in the record of observations. It was noted at $08^h 40^m$ GMT just before retiring. It was observed for some minutes, and its remarkable straightness and uniform width were considered quite unusual. The pulsation of the arc with about 45-second period was thought somewhat interesting, but in view of the faintness of illumination the observer was unfortunately not much impressed with the need for further observation, and only the equivalent of the following record was entered:

> *February 26, 1933*—$08^h 40^m$, GMT: Pulsating streak, extending from 85° west of north to 170° west of north, about 15° above the horizon at the extreme west to 65° above the horizon at the extreme east, auroral intensity 1, spectral intensity (with pocket spectroscope, perceived with difficulty) 1; a streak across southwestern sky, very straight and brightening and waning rhythmically with about 45-second period; glow from 30° west to 80° east of north, altitude 10° to 30°, auroral intensity 1, spectral intensity 1.

March 26, 1933

The following comments on the display were mainly written on March 27 in a letter to Andrew Thomson, Meteorological Service of Canada:

> *March 26, 1933*—$03^h 30^m$, GMT: Homogeneous streak, south of Ursa Major and north of Pleiades to about 10° east of zenith; of uniform width and very straight becoming more diffuse and rounded out at western-tip; width about 3°; western end brighter and more diffuse and not so sharply defined; between ends lighting very uniform—lighting was increasing.
>
> $04^h 15^m$: Had moved almost to zenith, well defined, had moved laterally south and getting brighter.
>
> $05^h 00^m$: Had continued south and Pleiades inside streak and eastern end slightly north of zenith; continued moving south laterally

[1] Carl Störmer, Remarkable aurora-forms from Southern Norway, Geofys. Pub., **11**, No. 5, 1-19 (1935).

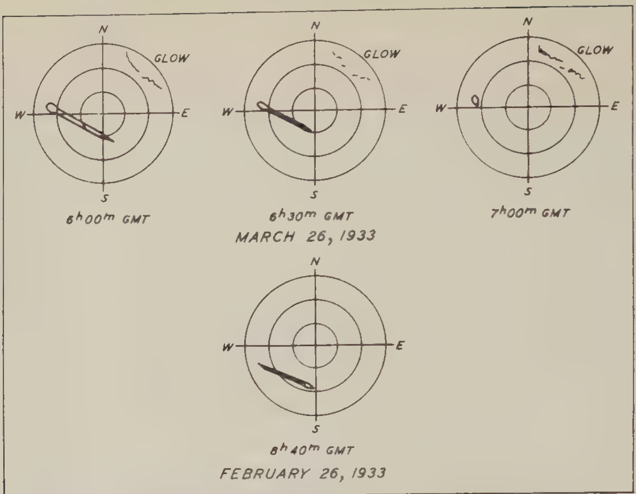

FIG. 1—POSITIONS OF HOMOGENEOUS THIN AURORAL ARCS, MEANOOK, 1933

and fading gradually after 05^{h} GMT; edges sharply defined from about $04^{h}\ 30^{m}$ to 05^{h}—more so than previously.

(The above observations were furnished, upon subsequent questioning, by Mr. Cook, who had gone to Colinton to get batteries, leaving here shortly before 03^{h} GMT and arriving back just before 06^{h}; when he left Colinton at $04^{h}\ 15^{m}$, there was a faint streak in the sky. Vestine had made the usual observations on the slight glow in the northeast but evidently because of the faintness of the streak and not having been out long enough in the darkness did not perceive it, although he read thermometers and put time-marks on thermogram and hydrogram at $04^{h}\ 00^{m}$. Cook's observations of it are somewhat casual as no particular importance was attached to it although he was interested by its remarkable straightness and lateral movement. After Cook returned Vestine went out and had a look at it and at once recognized it as the recurrence of the same form as that which occurred on February 26 and noticed its very rapid pulsation.)

$06^{h}\ 00^{m}$: Very pointed east and pulsating rapidly about one to two seconds progressively; streak had widened slightly; would disappear entirely and then come on practically instantaneously (verified by both of us, Vestine and Cook); tip reaching almost as far as Leo Alpha and about 5° north. Very similar pulsations timed with watch six seconds slow on chronometer No. 2658 beginning $06^{h}\ 20^{m}\ 40^{s}$ were:

Dim	Bright	Dim	Bright
$06^{h}\ 20^{m}\ 40^{s}$	$06^{h}\ 20^{m}\ 60^{s}$	$06^{h}\ 21^{m}\ 41^{s}$	$06^{h}\ 21^{m}\ 42^{s}$
21 22	21 24	22 10	22 12

Every pulsation was not timed as the intensity was weak and there was difficulty in deciding when gone and when bright, and in getting the time from watch written down also. Decided at this time to see if there was anything out of the ordinary in the way of magnetic activity in hut and was surprised to see the spot of light on the paper of the quick-run trace (which is quite open to view) oscillating violently. Decided to time periods and found that for the most part they were about two seconds by tick of watch but two or three times the spot returned and went back in less than half a second. A couple

of times the motion was of larger amplitude and moved more slowly which was timed by tick of watch at four to five seconds. (Watch has a loud tick which could be heard above the tick of the recorder-clocks.) Probably about 30 oscillations were observed. The amplitude was on the average about 6′ on *D* for most changes. With Cook, who had just finished changing papers on the recorders in cellar, obtained the following timings of dimness and brightness:

Dim	Bright	Dim	Bright
$06^h\,43^m\,43^s$	$06^h\,44^m\,12^s$	$06^h\,46^m\,37^s$	$06^h\,46^m\,42.5^s$
45 06	45 09	44	52
25	28	53	47 07
38	43	47 09	33
50	53	36	48 03
46 03	46 04	48 05	11
09	23	20	25.5
27	34	32	37
		43.5	

During this time the display was receding westwards and at the time of the last reading there was just a steady glow at the extreme western end. The data were then entered as given above.

There were many missing readings in the timings and it is certain that for the most part the actual timings would have run about two to three seconds, if we could have recorded them all, for the period during which timings were taken.

It might be added that at $06^h\,00^m$ the intensity was 1 and that, after getting accustomed to the darkness, the auroral green-line was definitely observed and its intensity estimated as 1. No clouds.

The weak, homogeneous auroral arc was very straight, with a practically uniform width of about 3°, and length from 30° to 60°. When first seen it was in the northern sky. It then moved southward laterally through the zenith, still preserving its direction and remarkable form, and finally assumed a rather steady position in the southwestern sky. At times the two ends were slightly rounded, broadened, and more diffuse; during the latter part of the display the eastern tip was sharply pointed. The arc pulsated with an average period of two seconds, as timed directly by count using a watch, and later by Cook and Vestine, one indicating times of dimness or brightness and the other timing by chronometer. The arc would disappear entirely except for the extreme western end and disappearance seemed progressive from east to west, and persisted about one second. It then reappeared suddenly and remained bright for about another second.

It is interesting to note that a similar arc appeared on February 26, in the same region of the sky, the interval of time between the two displays corresponding roughly with the time of a solar rotation.

April 1, 1933

This homogeneous arc was examined particularly for any evidence of pulsations in intensity without success. The record of the observations follows:

April 1, 1933—$05^h\,30^m$, GMT: Curved shaft, south of zenith and moving south laterally. At $04^h\,10^m$ a glow about Arcturus, barely discernible but auroral line present. At $05^h\,30^m$ a streak observed but not as complete as later; it brightened up from ends of streak

and rays formed on the northern edges of ends of streak; the central two-thirds of streak were uniformly illuminated (intensity 1) and conformed to a very smooth curve with edges marking the width uniformly; the curved shape of the shaft was very definite without breaks, the curvature being such that the eastern and western ends appeared further south than the center, which was 5° south of the southernmost star of Ursa Major. The rays at the ends of streak drifted north about 3° and then faded. The whole display had gradually faded and at $05^h 45^m$ a very bright portion, one-third of distance from western end, was all that was left; no pulsation; width of shaft 3°, length 150°; the eastern end developed from a diffuse spot in Boötes.

April 15, 1933

This arc closely resembled that of April 1 and was recorded as follows:

April 15, 1933—$06^h 00^m$, GMT: Curved shaft, at $06^h 05^m$, 10° south of Ursa Major and moving south laterally; width 3°. At $06^h 12^m$ through Boötes and apparently parallel to line if drawn through bottom two stars of bowl of Ursa Major; identical in most characteristics with that of April 1, but tips sharply pointed and twisted to point northwards. At $06^h 23^m$ striation developed on eastern half-portion, 1° in width; main streak fainter. Faint at $06^h 25^m$, brightening at $06^h 27^m$. At $06^h 37^m$ only eastern end about one-fifth original length had shifted and drifted north (about 5° north of Boötes). Absent at $06^h 39^m$. No pulsation noted. Camera with single meniscus lens exposed five minutes with no effect on film.

April 21, 1933

This homogeneous auroral arc was observed only for a period of seven minutes, but may have been present for some time before it was first observed at $04^h 55^m$ GMT. It was recorded as follows:

April 21, 1933—$04^h 55^m$, GMT: Curved shaft, width 2°, moving south rapidly; very even curvature. At $05^h 00^m$ had faded gradually from its western end and eastwards; shorter in length than in occurrences previously noted, its length extended from 5° south of southernmost star of Ursa Major to 2° south of Arcturus. Gone at $5^h 02^m$.

A display noted on April 22, at about 07^h GMT, may have been of similar type, but because it was seen only over 20° of arc of its length through clouds there is uncertainty about positive identification. Its description is given in the auroral summary.*

The 28-day interval between the displays of February 26 and March 26, and the 26-day interval between the displays of March 26 and April 21, may suggest recurrence of weakly penetrating solar particles from some active area of emission on the Sun. The fluctuations in the display of March 26 are suggestive of rapid oscillations of air in the upper atmosphere, perhaps occasioning the geomagnetic micropulsations accompanying the display, as well as the regular fluctuations of similar period in the luminosity of the auroral arc.

Grateful acknowledgement is made to J. Patterson, Controller, Meteorological Service of Canada, for the use of the foregoing data obtained by the writer at Meanook.

DEPARTMENT OF TERRESTRIAL MAGNETISM,
CARNEGIE INSTITUTION OF WASHINGTON,
Washington 15, D. C., November 12, 1943

*The summary is to be published in the March 1944 issue of the JOURNAL.

LIST OF GEOMAGNETIC OBSERVATORIES AND THESAURUS OF VALUES†—III

By J. A. Fleming and W. E. Scott

Table 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, +=N −=S	Longitude, east	Year	Declination, *D*	Inclination, *I*	Components of intensity: Horizontal, *H*	North, *X*	East, *Y*	Vertical, *Z*	Total, *F*
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
heltenham[2, 4, b]	+38 44	283 10	1901[2, c]	− 5 05.0	+70 21.6	20194	20115	−1789	+56586	60081
			1901[4, c]	− 5 05.0	+70 21.5	20195	20116	−1789	+56586	60082
			1902[2]	− 5 06.8	+70 21.9	20177	20097	−1798	+56555	60046
			1902[4]	− 5 06.8	+70 21.9	20178	20097	−1798	+56555	60047
			1903[2]	− 5 09.9	+70 22.9	20135	20053	−1813	+56486	59967
			1903[4]	− 5 10.0	+70 22.7	20138	20056	−1813	+56486	59970
			1904[2]	− 5 13.3	+70 24.1	20099	20016	−1829	+56451	59922
			1904[4]	− 5 13.3	+70 24.0	20101	20018	−1829	+56450	59922
			1905[2]	− 5 17.8	+70 25.6	20060	19974	−1852	+56418	59878
			1905[4]	− 5 17.8	+70 25.4	20064	19978	−1852	+56418	59878
			1906[2]	− 5 21.4	+70 27.0	20022	19935	−1869	+56383	59832
			1906[4]	− 5 21.5	+70 26.9	20024	19937	−1870	+56382	59832
			1907[2]	− 5 25.9	+70 29.2	19968	19878	−1890	+56348	59781
			1907[4]	− 5 26.0	+70 29.0	19972	19882	−1891	+56346	59781
			1908[2]	− 5 31.0	+70 30.9	19917	19825	−1915	+56289	59709
			1908[4]	− 5 31.1	+70 30.5	19922	19830	−1916	+56288	59710
			1909[2]	− 5 36.4	+70 33.2	19857	19762	−1940	+56240	59643
			1909[4]	− 5 36.4	+70 32.8	19863	19768	−1940	+56238	59642
			1910[2]	− 5 41.4	+70 35.6	19801	19703	−1963	+56209	59595
			1910[4]	− 5 41.4	+70 35.4	19806	19708	−1964	+56209	59596
			1911[2]	− 5 45.6	+70 37.6	19741	19641	−1981	+56141	59511
			1911[4]	− 5 45.6	+70 37.4	19745	19645	−1982	+56141	59512
			1912[2]	− 5 49.9	+70 39.2	19680	19578	−2000	+56052	59406
			1912[4]	− 5 50.0	+70 39.1	19682	19579	−2000	+56052	59407
			1913[2]	− 5 54.6	+70 41.2	19597	19493	−2018	+55917	59252
			1913[4]	− 5 54.6	+70 41.1	19599	19495	−2018	+55917	59253
			1914[2]	− 5 59.8	+70 44.1	19507	19400	−2038	+55815	59126
			1914[4]	− 5 59.8	+70 44.0	19510	19403	−2038	+55815	59127
			1915[2]	− 6 03.9	+70 47.0	19412	19303	−2051	+55694	58980
			1915[4]	− 6 04.0	+70 46.8	19417	19308	−2052	+55694	58982
			1916[2]	− 6 07.6	+70 49.9	19336	19226	−2064	+55625	58890
			1916[4]	− 6 07.7	+70 49.6	19341	19231	−2065	+55624	58891
			1917[2]	− 6 10.3	+70 51.8	19270	19158	−2072	+55533	58781
			1917[4]	− 6 10.4	+70 51.5	19276	19164	−2073	+55532	58782
			1918[2]	− 6 12.4	+70 53.5	19213	19100	−2077	+55458	58692
			1918[4]	− 6 12.4	+70 53.0	19221	19108	−2078	+55456	58693
			1919[2]	− 6 15.0	+70 54.8	19160	19046	−2086	+55373	58594
			1919[4]	− 6 15.0	+70 54.4	19168	19053	−2087	+55371	58595
			1920[2]	− 6 18.5	+70 55.7	19113	18997	−2100	+55286	58497
			1920[4]	− 6 18.5	+70 55.4	19118	19002	−2101	+55285	58498
			1921[2]	− 6 22.4	+70 56.8	19065	18947	−2116	+55200	58400
			1921[4]	− 6 22.4	+70 56.5	19069	18951	−2117	+55200	58401
			1922[2]	− 6 27.7	+70 57.9	19016	18895	−2140	+55115	58303
			1922[4]	− 6 27.7	+70 57.6	19020	18899	−2140	+55115	58305
			1923[2]	− 6 32.0	+70 58.4	18973	18850	−2159	+55018	58198
			1923[4]	− 6 32.0	+70 58.3	18976	18853	−2159	+55018	58199
			1924[2]	− 6 35.8	+70 59.2	18924	18799	−2174	+54920	58089
			1924[4]	− 6 35.8	+70 59.0	18927	18802	−2174	+54920	58090
			1925[2]	− 6 39.3	+71 00.4	18870	18743	−2187	+54824	57981
			1925[4]	− 6 39.4	+71 00.2	18874	18746	−2188	+54824	57981
			1926[2]	− 6 42.8	+71 02.2	18809	18680	−2199	+54740	57881
			1926[4]	− 6 42.8	+71 01.7	18817	18688	−2200	+54738	57882
			1927[2]	− 6 45.8	+71 02.9	18765	18634	−2210	+54646	57778
			1927[4]	− 6 45.7	+71 02.6	18769	18639	−2210	+54645	57779
			1928[2]	− 6 49.1	+71 04.4	18705	18573	−2221	+54551	57669
			1928[4]	− 6 49.0	+71 04.1	18711	18579	−2221	+54550	57670
			1929[2]	− 6 52.0	+71 06.5	18646	18512	−2229	+54485	57587
			1929[4]	− 6 52.0	+71 06.1	18653	18519	−2230	+54483	57588
			1930[2]	− 6 56.0	+71 08.4	18583	18447	−2243	+54402	57488
			1930[4]	− 6 55.9	+71 08.0	18591	18455	−2244	+54402	57491
			1931[2]	− 7 00.2	+71 09.3	18539	18401	−2260	+54316	57393
			1931[4]	− 7 00.0	+71 09.0	18543	18404	−2260	+54316	57394
			1932[2]	− 7 03.7	+71 11.2	18482	18342	−2272	+54248	57310
			1932[4]	− 7 03.7	+71 10.9	18487	18347	−2273	+54248	57311
			1933[2]	(− 7 06.2)	(+71 12.8)	(18432)	(18291)	(−2279)	(+54185)	(57234)
			1934[2]	(− 7 06.8)	(+71 14.2)	(18384)	(18242)	(−2277)	(+54117)	(57154)
			1935[2]	(− 7 06.4)	(+71 16.3)	(18335)	(18194)	(−2268)	(+54079)	(57103)
			1936[2]	(− 7 06.2)	(+71 17.9)	(18291)	(18151)	(−2262)	(+54035)	(57047)
			1937[2]	(− 7 05.5)	(+71 20.2[d])	(18250)	(18110)	(−2253)	(+54031[d])	(57030[d])
			1938[2]	(− 7 05.1)	(+71 21.5)	(18216)	(18077)	(−2247)	(+53998)	(56988)

[b]The values of intensity for 1901 through 1912 differ from those originally published, because beginning with 1913 all results were referred to international magnetic standard (*Researches* of the Department of Terrestrial Magnetism, Carnegie Institution of Washington, 2, 270-273); this change required a correction of −0.001 *H* to be applied retroactively to earlier values of *H* and a similar one for the other intensity-elements. [c]Six months, July to December, 1901. [d]A change in standard for *I* of +0′.8 was made at the beginning of 1937; this change amounts to +41γ in *Z* and +39γ in *F*.

†Continued from Terr. Mag., **48**, 97-108 (which see for numbered footnotes) and 171-182 (1943).

TABLE 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, + =N − =S	Longitude, east	Year	Declination, D	Inclination, I	Components of intensity: Horizontal, H	North, X	East, Y	Vertical, Z	Total, F
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
Cheltenham[2]—Continued	+38 44	283 10	1939[2]	(− 7 05.0)	(+71 22.5)	(18189)	(18050)	(−2243)	(+53970)	(56953)
			1940[2]	(− 7 04.8)	(+71 22.9)	(18176)	(18037)	(−2240)	(+53953)	(56932)
			1941[2]	(− 7 05.4)	(+71 23.2)	(18168)	(18029)	(−2242)	(+53941)	(56918)
			1942[2]	(− 7 05.9)	(+71 22.2)	(18179)	(18040)	(−2246)	(+53924)	(56906)
Athens[e]	+37 59	23 42	1899	− 5 45.2	+52 08.4	.....	.....	......	......	....
			1900	− 5 42.3	+52 07.7	26063	25934	−2591	+33514	42455
			1901	− 5 34.1	+52 07.4	26090	25967	−2532	+33541	42493
			1902	− 5 26.6	+52 04.7	26141	26023	−2480	+33541	42525
			1903	− 5 20.2	+52 04.2	26114	26001	−2429	+33508	42482
			1904[f]	− 5 20.2	+52 09.1	26275	26161	−2444	+33691	42725
			1905	− 5 18.2	+52 09.5	26140	26028	−2416	+33598	42569
			1906	− 5 10.4	+52 11.9	26099	25993	−2353	+33604	42549
			1907	− 4 59.8	+52 07.3	26016	25917	−2266	+33477	42397
			1908	− 4 53.0	+52 11.7	26197	26102	−2230	+33613	42616
San Miguel* (Ponta Delgada)	+37 46	234 21	1913[g]	−19 53.2	+60 49.5	23059	21684	−7844	+41283	47286
			1914[g]	−19 49.4	+60 46.2	23063	21696	−7821	+41216	47230
			1915[g]	−19 53.2	+60 49.5	23059	21684	−7844	+41282	47286
			1916[g]	−19 42.7	+60 39.1	23072	21720	−7782	+41033	47074
			1917	−19 33.5	+60 36.4	23088	21743	−7765	+40986	47042
			1918	−19 29.1	+60 32.7	23090	21756	−7734	+40886	46955
			1919	−19 24.6	+60 29.5	23105	21779	−7715	+40824	46909
			1920	−19 20.2	+60 26.0	23123	21808	−7686	+40759	46861
			1921	−19 15.9	+60 20.8	23132	21837	−7632	+40621	46748
			1922	−19 10.8	+60 17.0	23189	21902	−7618	+40630	46782
			1923	−19 05.5	+60 11.9	23204	21928	−7590	+40514	46690
			1924	−19 01.1	+60 07.4	23245	21976	−7575	+40459	46660
			1925	−18 56.5	+60 03.0	23256	21997	−7549	+40378	46596
			1926	−18 50.9	+60 00.4	23247	22000	−7510	+40275	46502
			1927	−18 44.1	+59 57.4	23278	22045	−7477	+40249	46496
			1928	−18 40.5	+59 52.6	23324	22096	−7468	+40197	46474
			1929	−18 35.0	+59 48.0	23309	22094	−7428	+40046	46336
			1930	−18 29.4	+59 46.4	23310	22107	−7393	+40004	46300
			1931	−18 23.1	+59 41.1	23351	22159	−7365	+39936	46262
			1932	−18 18.3	+59 37.9	23334	22153	−7329	+39822	46155
			1933	−18 12.5	+59 35.7	23374	22204	−7304	+39820	46172
			1934	−18 08.0	+59 32.5	23394	22232	−7281	+39782	46150
			1935	−18 01.9	+59 28.3	23405	22255	−7245	+39690	46078
			1936	(−17 56.7)	(+59 24.9)	(23427)	(22287)	(−7218)	(+39638)	(46043)
			1937	(−17 51.9)	(+59 22.6)	(23460)	(22329)	(−7197)	(+39633)	(46056)
Zinsen[1, h]	+37 30	126 38	1918	− 5 41.1	+53 16	29978	29831	−2970	+40170	50123
			1919	....	....	.....	.....	......	....	.....
			1920	....	....	.....	.....	......	....	.....
			1921	− 5 30.7	+53 19.9	29960	29821	−2878	+40241	50169
			1922	− 5 36.7	+53 13.9	29972	29828	−2931	+40111	50072
			1923	− 5 49.3	+53 14.0	29921	29767	−3035	+40045	49989
			1924	− 5 51.1	+53 05.9	29970	29814	−3056	+39914	49913
			1925	− 5 54.3	+53 09.9	30017	29858	−3088	+40073	50069
			1926	− 5 57.8	+53 09.0	30001	29839	−3117	+40030	50025
			1927	− 5 59.3	+53 07.7	29971	29807	−3127	+39959	49950
			1928	− 6 00.8	+53 12.8	29965	29800	−3139	+40074	50038
			1929	− 6 02.4	+53 16.1	29923	29757	−3149	+40099	50033
			1930	− 6 03.8	+53 07.9	29831	29664	−3151	+39777	49720
			1931	− 6 03.9	+53 11.7	29866	29699	−3156	+39915	49852
			1932	− 6 03.7	+53 10.9	30006	29838	−3169	+40083	50070
			1933	− 6 02.6	+53 12.1	30059	29892	−3165	+40183	50182
			1934	− 6 03.9	+53 12.7	30069	29901	−3177	+40211	50210
			1935	− 6 06.0	+53 14.0	30087	29917	−3197	+40267	50266
			1936	− 6 08.6	+53 14.3	30105	29932	−3223	+40298	50302
			1937	(− 6 09.6)	(+53 14.3)	(30123)	(29949)	(−3232)	(+40322)	(50332)
			1938	(− 6 11.6)	(+53 17.2)	(30130)	(29954)	(−3251)	(+40403)	(50400)
San Fernando[i]	+36 28	353 48	1891	−16 39.2	+55 52.7	24329	23309	−6972	+35905	43371
			1892	−16 33.2	+55 50.8	24349	23340	−6937	+35891	43371
			1893	−16 28.3	+55 44.3	24382	23381	−6913	+35794	43309
			1894	−16 22.9	+55 39.7	24403	23412	−6883	+35722	43262
			1895	−16 19.2	+55 36.3	24432	23448	−6865	+35689	43251

[e]Values for 1899 are from absolute observations; values from 1900 are from magnetograms. [f]Electric-railway disturbances from 1904. [g]The values of D for 1913, 1914, 1915, and 1916 are based on absolute observations but beginning with 1917 they are means from magnetograms; all values for I and H are means of absolute observations and components are computed; in some cases the published values of F do not agree with computed values and when difference has exceeded 2γ the computed values are given. [h]Weekly absolute observations. [i]The values for D and H are from magnetograms for all days; values of I are from absolute observations which in later years show great and irregular differences between values by two needles.

TABLE 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, +=N −=S	Longitude, east	Year	Declination, *D*	Inclination, *I*	Components of intensity: Horizontal, *H*	North, *X*	East, *Y*	Vertical, *Z*	Total, *F*
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
San Fernando—Continued	+36 28	353 48	1896	−16 14.7	+55 32.3	24469	23492	−6845	+35654	43243
			1897	−16 10.6	+55 27.4	24518	23547	−6831	+35615	43239
			1898	−16 06.9	+55 22.8	24555	23590	−6816	+35568	43221
			1899	−16 02.8	+55 16.6	24594	23636	−6798	+35487	43176
			1900	−15 59.3	+55 09.2	24631	23678	−6784	+35378	43108
			1901	−15 55.8	+55 08.3	24664	23717	−6769	+35405	43149
			1902	−15 51.0	+55 04.4	24650	23713	−6732	+35300	43055
			1903	−15 48.4	+55 02.4	24699	23765	−6728	+35326	43104
			1904	−15 44.6	+54 59.9	24741	23813	−6713	+35332	43133
			1905	−15 40.3	+54 54.2	24762	23841	−6689	+35237	43067
			1906	−15 36.5	+54 52.6	24796	23882	−6672	+35251	43098
			1907	−15 31.8	+54 52.8	24809	23903	−6642	+35273	43124
			1908	−15 25.6	+54 48.4	24829	23934	−6605	+35206	43081
			1909	−15 19.5	+54 43.4	24849	23965	−6567	+35126	43027
			1910	−15 13.6	+54 38.1	24879	24006	−6534	+35053	42985
			1911	−15 05.2	+54 31.5	24894	24036	−6479	+34932	42895
			1912	−14 54.3	+54 26.7	24923	24084	−6411	+34870	42861
			1913	−14 51.7	+54 26.6	24939	24105	−6397	+34890	42887
			1914	−14 44.0	+54 23.7	24977	24156	−6352	+34881	42901
			1915	−14 36.0	+54 19.1	24978	24171	−6296	+34784	42823
			1916	−14 28.5	+54 15.8	24958	24166	−6238	+34686	42732
			1917	−14 21.1	+54 09.0	24986	24206	−6193	+34580	42662
			1918	−14 12.4	+54 02.2	24976	24212	−6130	+34423	42529
			1919	−14 08.5	+53 44.6	25012	24254	−6111	+34104	42293
			1920	−14 01.0	+53 37.5	25021	24276	−6060	+33969	42189
			1921	−13 50.6	+53 45.4	25041	24314	−5992	+34160	42355
			1922	−13 41.6	+53 50.1	25033	24321	−5926	+34247	42421
			1923	−13 32.6	+53 48.7	25027	24331	−5861	+34210	42387
			1924	−13 23.5	+53 46.8	25016	24336	−5794	+34155	42336
			1925	−13 15.1	+53 40.0	25032	24365	−5738	+34035	42249
			1926	−13 07.7	+53 38.6	25020	24366	−5683	+33990	42206
			1927	−12 57.1	+53 37.7	25051	24414	−5615	+34014	42243
			1928	−12 48.8	+53 32.2	25039	24415	−5553	+33884	42132
			1929	−12 40.7	+53 29.8	25035	24425	−5495	+33829	42085
			1930	−12 32.8	+53 29.9	25072	24473	−5447	+33881	42149
			1931	−12 25.9	+53 27.9	25106	24517	−5405	+33885	42172
			1932	−12 18.0	+53 24.2	25129	24552	−5353	+33840	42150
			1933	−12 08.1	+53 21.1	25148	24586	−5287	+33806	42134
			1934	−12 01.9	+53 15.6	25190	24637	−5251	+33748	42113
			1935	−11 53.0	+53 11.2	25258	24717	−5201	+33747	42153
			1936	−11 44.4	+53 11.6	25261	24733	−5140	+33759	42164
			1937	−11 37.9	+53 08.5	25277	24758	−5096	+33717	42140
			1938	−11 30.6	+53 06.6	25290	24781	−5046	+33695	42130
			1939	−11 25.0	+53 04.2	25339	24838	−5016	+33712	42173
			1940	−11 17.1	+53 01.4	25358	24868	−4962	+33680	42159
			1941	−11 11.2	+52 58.5	25402	24919	−4928	+33679	42185
Kakioka[2] (Succeeding Tokio)	+36 14	140 11	1913	− 5 10.1	+49 30.9	29749	29628	−2680	+34851	45822
			1914	− 5 12.9	+49 29.8	29783	29660	−2707	+34868	45856
			1915	− 5 15.6	+49 31.3	29752	29627	−2727	+34863	45832
			1916[i]	− 5 17.6	+49 31.7	29743	29616	−2744	+34859	45824
			1924[k]	− 5 31.6	+49 29.5	29708	29570	−2861	+34774	45736
			1925	− 5 34.4	+49 27.8	29716	29575	−2886	+34749	45722
			1926	− 5 36.6	+49 27.7	29694	29552	−2903	+34721	45687
			1927	− 5 39.6	+49 27.6	29702	29557	−2929	+34727	45697
			1928	− 5 40.5	+49 27.0	29707	29561	−2938	+34721	45695
			1929	− 5 41.9	+49 26.0	29704	29557	−2949	+34698	45676
			1930	− 5 42.4	+49 27.9	29713	29566	−2955	+34746	45718
			1931	− 5 42.8	+49 27.6	29734	29586	−2960	+34765	45746
			1932	− 5 44.3	+49 28.7	29722	29573	−2972	+34773	45745
			1933	− 5 45.5	+49 28.7	29723	29573	−2982	+34775	45747
			1934	− 5 47.1	+49 29.5	29720	29569	−2996	+34788	45755
			1935	− 5 49.5	+49 30.9	29719	29566	−3016	+34815	45774
			1936	(− 5 51.7)	(+49 31.6)	(29713)	(29558)	(−3034)	(+34823)	(45776)
			1937	(− 5 52.9)	(+49 32.2)	(29719)	(29563)	(−3045)	(+34841)	(45795)
			1938	(− 5 55.9)	(+49 34.3)	(29699)	(29540)	(−3069)	(+34862)	(45797)
Tsingtao[2]	+36 04	120 19	1916	− 4 04.7	+52 07.1	30842	30764	−2193	+39644	50228
			1917	− 4 07.0	+52 06.1	30851	30771	−2215	+39631	50224
			1918	− 4 08.2	+52 06.9	30827	30747	−2224	+39621	50201
			1919	− 4 09.9	+52 07.4	30812	30731	−2238	+39613	50185
			1920	− 4 12.9	+52 07.0	30817	30734	−2265	+39610	50186

[i]The great fire which followed the earthquake of September 1, 1923, destroyed the main building of the Observatory and all magnetograms from January, 1917, to August, 1923, were also lost by the fire at Tokio. In 1916 it was found that absolute values at Tokio were approximately obtained from those at Kakioka by applying the following corrections: −5′.54 for *D*, +264.7γ for *H*; and 481.4γ for *Z*. [k]Eleven months, February to December, 1924.

Table 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, + =N − =S	Longitude, east	Year	Declination, *D*	Inclination, *I*	Components of intensity: Horizontal, *H*	North, *X*	East, *Y*	Vertical, *Z*	Total, *F*
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
Tsingtao—Continued	+36 04	120 19	1924	− 4 21.3	+52 07.0	30816	30727	−2340	+39609	50185
			1925	− 4 22.6	+52 05.9	30831	30741	−2353	+39603	50189
			1926	− 4 27.0	+52 11.9	30823	30730	−2392	+39750	50301
			1927	− 4 29.8	+52 07.7	30824	30729	−2417	+39627	50204
			1928	− 4 30.1	+52 09.6	30837	30742	−2420	+39698	50268
			1929	− 4 32.6	+52 08.0	30856	30759	−2444	+39683	50268
			1930	− 4 32.8	+52 06.6	30868	30771	−2447	+39667	50262
			1931	− 4 32.1	+52 05.2[1]	30880[1]	30783	−2442	+39648[1]	50255
			1932	− 4 32.1	+52 05.1	30892	30795	−2443	+39662	50273
			1933	− 4 34.1	+52 05.2	30901	30803	−2461	+39675	50289
			1934	− 4 34.9	+52 05.1	30919	30821	−2470	+39697	50317
			1935	− 4 36.6	+52 05.6	30923	30823	−2485	+39714	50333
			1936	(− 4 37.6)	(+52 06.1)	(30935)	(30834)	(−2495)	(+39741)	(50361)
Tokio[l] (Superseded by Kakioka)	+35 41	139 45	1900	− 4 33.7	+49 00.7	29909	29814	−2379	+34421	45600
			1901	− 4 36.1	+49 00.0	29954	29857	−2403	+34459	45658
			1902	− 4 38.3	+48 57.6	29903	29805	−2418	+34350	45542
			1903	− 4 40.7	+48 57.8	29929	29829	−2441	+34384	45585
			1904	− 4 43.4	+48 57.1	29941	29839	−2465	+34384	45593
			1905	− 4 46.2	+48 56.1	29952	29848	−2491	+34376	45594
			1906	− 4 48.9	+48 58.8	29986	29880	−2517	+34470	45687
			1907	− 4 50.7	+48 59.2	29951	29844	−2530	+34438	45640
			1908	− 4 53.2	+48 56.9	29991	29882	−2555	+34439	45667
			1909	− 4 55.7	+49 01.8	30005	29894	−2578	+34554	45763
			1910	− 4 58.2	+49 07.3	30007	29894	−2600	+34668	45851
			1911	− 5 00.6	+49 05.0	30025	29910	−2622	+34640	45841
			1912	− 5 03.4	+48 53.7	29996	29879	−2644	+34379	45625
Los Angeles[m]	+34 03	241 45	1882[n]	+14 32.0	+59 30.6[o]	27249[p]	26377	+6838	+46278	53704
			1883	+14 30.8	+59 30.7	27283	26412	+6837	+46339	53774
			1884	+14 29.2	+59 29.5[o]	27269[p]	26402	+6821	+46278	53715
			1885	+14 29.4	+59 29.6[o]	27245[o,p]	26378	+6817	+46241	53670
			1886	+14 28.7	+59 32.3[o]	27235[o,p]	26370	+6809	+46307	53722
			1887	+14 28.2	+59 30.1[o]	27238[p]	26374	+6806	+46244	53670
			1888	+14 23.5	+59 29.9[o]	27231[p]	26376	+6768	+46226	53650
			1889[q]	+14 22.6	+59 29.2[o]	27220[p]	26368	+6759	+46186	53610
Ksara	+33 49	35 53	1930[r]	+ 1 27.7	....	.....	.....	......	....	.....
			1931	+ 1 26.9	....	.....	.....	......	....	.....
			1932	+ 1 29.9	....	.....	.....	......	....	.....
			1933	+ 1 36.3	....	.....	.....	......	....	.....
			1934	+ 1 40.7	....	.....	.....	......	....	.....
			1935	+ 1 44.9	....	.....	.....	......	....	.....
			1936[2]	+ 1 48.4	....	28557	28543	+ 900	....	.....
			1937[2]	+ 1 51.7	+48 12.4	28586	28571	+ 929	+31979	42893
Tucson[2, 4, s]	+32 15	239 10	1910[2]	+13 25.9	+59 19.9	27374	26625	+6359	+46161	53667
			1910[4]	+13 25.8	+59 19.6	27379	26629	+6359	+46160	53669
			1911[2]	+13 29.8	+59 20.1	27339	26584	+6381	+46109	53605
			1911[4]	+13 29.7	+59 19.9	27343	26589	+6381	+46109	53606
			1912[2]	+13 33.6	+59 20.4	27302	26541	+6401	+46055	53539
			1912[4]	+13 33.5	+59 20.3	27304	26542	+6402	+46055	53539
			1913[2]	+13 37.1	+59 21.9	27245	26479	+6415	+46006	53468
			1913[4]	+13 37.0	+59 21.8	27247	26481	+6415	+46006	53469
			1914[2]	+13 39.9	+59 23.3	27185	26415	+6422	+45947	53387
			1914[4]	+13 39.9	+59 23.1	27188	26419	+6423	+45946	53388
			1915[2]	+13 42.6	+59 25.1	27114	26341	+6426	+45880	53293
			1915[4]	+13 42.5	+59 24.7	27119	26347	+6427	+45879	53295
			1916[2]	+13 44.5	+59 26.4	27057	26283	+6427	+45824	53216
			1916[4]	+13 44.4	+59 26.1	27063	26288	+6428	+45824	53218
			1917[2]	+13 46.2	+59 26.9	27014	26238	+6430	+45765	53143
			1917[4]	+13 46.1	+59 26.4	27021	26244	+6431	+45763	53145
			1918[2]	+13 47.2	+59 27.1	26973	26196	+6428	+45703	53069
			1918[4]	+13 47.1	+59 26.5	26982	26205	+6429	+45701	53072
			1919[2]	+13 47.9	+59 27.5	26932	26155	+6423	+45646	52999
			1919[4]	+13 47.8	+59 27.0	26940	26163	+6424	+45644	53001
			1920[2]	+13 48.0	+59 27.9	26904	26127	+6418	+45611	52955
			1920[4]	+13 48.0	+59 27.6	26910	26133	+6419	+45610	52957
			1921[2]	+13 47.8	+59 28.3	26869	26094	+6408	+45564	52896
			1921[4]	+13 47.7	+59 28.0	26875	26100	+6408	+45564	52899

[l]The Observatory was removed in January, 1913, to Kakioka because of interference by electric tramway. [m]The values of *D* are derived from tabulations in the original publications with corrections to offset changes in base-line values which were disregarded heretofore, values of *H* are derived from original publications with a correction of $-0.001H$, to reduce them to the international magnetic standard adopted in 1913, and the values of *F*, under the requirement that they must conform with those of *I* and *H*, embody a similar correction. [n]Three months, October to December, 1882. [o]Based on absolute observations made on three days near the middle of each month. [p]Monthly means of *H*, on which these entries depend, were expressed to four significant figures only. [q]Nine months, January to September, 1889. [r]Three months, October to December, 1930. [s]See footnote [b] for Cheltenham.

TABLE 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, +=N −=S	Longitude, east	Year	Declination, D	Inclination, I	Components of intensity: Horizontal, H	North, X	East, Y	Vertical, Z	Total, F
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
Tucson[2,4]—Continued	+32 15	239 10	1922[2]	+13 47.6	+59 29.2	26835	26061	+6398	+45534	52853
			1922[4]	+13 47.5	+59 29.0	26839	26065	+6399	+45533	52855
			1923[2,t]	+13 47.2	+59 28.9	26784	26012	+6383	+45437	52744
			1923[4,t]	+13 47.2	+59 28.7	26788	26016	+6384	+45437	52745
			1924[2]	+13 46.4	+59 29.4	26743	25974	+6367	+45383	52676
			1924[4]	+13 46.4	+59 29.2	26746	25978	+6368	+45383	52678
			1925[2]	+13 45.3	+59 30.6	26694	25928	+6347	+45334	52609
			1925[4]	+13 45.2	+59 30.3	26698	25933	+6348	+45334	52612
			1926[2]	+13 44.7	+59 32.2	26635	25872	+6329	+45284	52536
			1926[4]	+13 44.5	+59 31.7	26643	25881	+6329	+45283	52540
			1927[2]	+13 43.4	+59 32.6	26585	25826	+6307	+45210	52447
			1927[4]	+13 43.9	+59 32.3	26590	25830	+6312	+45209	52449
			1928[2]	+13 44.7	+59 33.5	26535	25775	+6305	+45152	52372
			1928[4]	+13 44.6	+59 33.2	26541	25782	+6305	+45151	52374
			1929[2]	+13 45.8	+59 34.8	26489	25728	+6302	+45112	52314
			1929[4]	+13 45.7	+59 34.6	26496	25735	+6303	+45111	52317
			1930[2]	+13 47.7	+59 36.8	26435	25672	+6303	+45081	52260
			1930[4]	+13 47.6	+59 36.2	26444	25681	+6305	+45080	52263
			1931[2]	(+13 49.5)	(+59 37.4)	(26399)	(25634)	(+6308)	(+45038)	(52205)
			1931[4]	+13 49.4	+59 37.1	26404	25639	+6309	+45037	52206
			1932[2]	(+13 51.1)	(+59 39.1)	(26355)	(25589)	(+6310)	(+45014)	(52162)
			1932[4]	+13 51.0	+59 38.8	26361	25594	+6311	+45013	52164
			1933[2]	(+13 52.1)	(+59 39.8)	(26320)	(25553)	(+6309)	(+44972)	(52108)
			1933[4]	+13 52.0	+59 39.3	26326	25559	+6309	+44971	52110
			1934[2]	(+13 52.0)	(+59 39.8)	(26295)	(25529)	(+6302)	(+44934)	(52062)
			1934[4]	+13 51.9	+59 39.6	26299	25533	+6302	+44933	52064
			1935[2]	(+13 52.0)	(+59 40.4)	(26260)	(25495)	(+6294)	(+44891)	(52008)
			1936[2]	(+13 51.3)	(+59 41.0)	(26230)	(25467)	(+6281)	(+44856)	(51962)
			1937[2]	(+13 50.5)	(+59 41.2)	(26195)	(25434)	(+6267)	(+44805)	(51901)
			1938[2]	(+13 49.5)	(+59 40.8)	(26172)	(25414)	(+6254)	(+44753)	(51844)
			1939[2]	(+13 49.2)	(+59 40.8)	(26153)	(25396)	(+6247)	(+44719)	(51805)
			1940[2]	+13 48.2	(+59 40.6)	(26136)	(25381)	(+6236)	(+44684)	(51766)
			1941[2]	(+13 47.4)	(+59 40.7)	(26112)	(25359)	(+6224)	(+44647)	(51722)
			1942[2]	(+13 46.1)	(+59 39.6)	(26109)	(25359)	(+6214)	(+44608)	(51687)
Lukiapang[2] (Succeeding Zikawei)	+31 19	121 02	1908[u]	− 2 56.2	+45 35.2	33173	33129	−1700	+33879	47416
			1909	− 2 58.6	+45 34.8	33187	33142	−1724	+33879	47434
			1910	− 3 01.1	+45 34.3	33201	33155	−1748	+33883	47447
			1911	− 3 02.5	+45 33.9	33205	33158	−1762	+33884	47453
			1912	− 3 04.6	+45 32.9	33202	33155	−1782	+33868	47444
			1913	− 3 07.2	+45 32.6	33209	33160	−1807	+33868	47448
			1914	− 3 09.5	+45 31.7	33202	33152	−1830	+33844	47429
			1915	− 3 13.2	+45 32.1	33190	33138	−1864	+33839	47414
			1916	− 3 16.0	+45 31.9	33179	33125	−1890	+33823	47395
			1917	− 3 17.8	+45 31.5	33180	33125	−1908	+33815	47390
			1918	− 3 18.8	+45 31.0	33185	33129	−1918	+33817	47399
			1919	− 3 20.0	+45 31.0	33167	33111	−1929	+33790	47362
			1920	− 3 21.4	+45 30.7	33155	33098	−1941	+33773	47341
			1921	− 3 24.0	+45 30.5	33169	33110	−1967	+33784	47359
			1922	− 3 25.1	+45 30.5	33183	33124	−1978	+33799	47380
			1923	− 3 25.9	+45 29.3	33205	33146	−1988	+33777	47365
			1924	− 3 28.5	+45 29.0	33200	33140	−2012	+33764	47352
			1925	− 3 30.5	+45 28.0	33160	33098	−2030	+33709	47282
			1926	− 3 32.6	+45 28.8	33203	33140	−2052	+33763	47354
			1927	− 3 34.0	+45 27.2	33264	33200	−2070	+33794	47419
			1928	− 3 35.3	+45 26.1[v]	33233	33168	−2080	+33737[v]	47354[v]
			1929	− 3 35.8	+45 25.5	33269	33204	−2087	+33766	47402
			1930	− 3 35.8	+45 25.3	33262	33196	−2086	+33755	47390
			1931	− 3 35.3	+45 23.2	33306	33240	−2084	+33758	47422
			1932	− 3 34.9	+45 24.4	33316	33251	−2081	+33792	47454
			1933	− 3 35.4	+45 23.7	33329	33263	−2087	+33791	47462
Zikawei[x] (Succeeded by Lukiapang)	+31 12	121 26	1899	− 2 20.3	+45 47.6	32825	32798	−1339	+33747	47078
			1900	− 2 22.2	+45 45.5	32859	32831	−1359	+33741	47097
			1901[w]	− 2 24.7	+45 41.6	32891	32862	−1384	+33697	47088
			1902	− 2 25.1	+45 40.0	32939	32910	−1390	+33715	47135
			1903	− 2 27.3	+45 38.8	32957	32927	−1412	+33708	47142
			1904	− 2 28.2	+45 38.3	32985	32954	−1422	+33729	47177
			1905	− 2 30.3	+45 37.1	33009	32977	−1443	+33729	47194
			1906	− 2 32.0	+45 35.3	33040	33008	−1460	+33726	47213
			1907	− 2 33.6	+45 36.6	33056	33023	−1476	+33768	47254
			1908[x]	− 2 35.4	+45 35.4	33078	33044	−1495	+33766	47268

[t]An abrupt decrease due to a change in the constants of the magnetometer for H-measurements, beginning with 1923, was made, which amounted to -10γ in H, -10γ in X, -2γ in Y, -17γ in Z, and 20γ in F. [u]Five months, August to December, 1908. [v]Five months, June to September and December, 1928. [w]New buildings occupied in 1901; observations at old and new sites show small differences in D and H. [x]Two months only, January and February, 1908; electric car lines in Shanghai began operation at end of February and made it necessary to discontinue recording at Zikawei, after 31 years (from February, 1877), and removal of instruments to new station at Lukiapang.

TABLE 1—*Annual values of geomagnetic elements at observatories*—Continued

Observatory	Latitude, +=N −=S	Longitude, east	Year	Declination, D	Inclination, I	Components of intensity: Horizontal, H	North, X	East, Y	Vertical, Z	Total, F
	° ′	° ′		° ′	° ′	γ	γ	γ	γ	γ
Zô-sè[z, a]	+31 06	121 11	1908[z]	− 2 45.6	+45 43.2	33084	33047	−1591	+33927	47388
			1909	− 2 47.9	+45 42.5	33098	33060	−1615	+33928	47398
			1910	− 2 50.4	+45 42.1	33112	33073	−1639	+33933	47412
			1911	− 2 51.8	+45 41.6	33116	33076	−1654	+33928	47411
			1912	− 2 54.0	+45 40.6	33114	33073	−1674	+33905	47392
			1913	− 2 56.5	+45 40.3	33120	33078	−1699	+33908	47399
			1914	− 2 58.8	+45 39.4	33113	33069	−1721	+33881	47375
			1915	− 3 02.5	+45 39.8	33101	33055	−1755	+33878	47365
			1916	− 3 05.3	+45 39.6	33090	33042	−1782	+33862	47345
			1917	− 3 07.1	+45 39.2	33091	33042	−1799	+33855	47341
			1918	− 3 08.1	+45 38.7	33096	33047	−1809	+33850	47341
			1919	− 3 09.3	+45 38.7	33078	33028	−1820	+33831	47315
			1920	− 3 10.7	+45 38.4	33066	33016	−1833	+33813	47293
			1921	− 3 13.3	+45 38.2	33080	33028	−1858	+33825	47312
			1922	− 3 14.4	+45 38.2	33094	33042	−1870	+33839	47332
			1923	− 3 15.2	+45 37.0	33116	33064	−1879	+33838	47347
			1924	− 3 17.8	+45 36.6	33111	33057	−1903	+33826	47334
			1925	− 3 19.8	+45 35.7	33071	33016	−1921	+33771	47264
			1926	− 3 22.0	+45 36.5	33114	33057	−1944	+33824	47336
			1927	− 3 23.3	+45 34.9	33175	33118	−1961	+33856	47400
			1928	− 3 24.6	+45 33.8[a]	33144	33086	−1971	+33799[a]	47336[a]
			1929	− 3 25.2	+45 33.2	33180	33121	−1979	+33827	47383
			1930	− 3 25.1	+45 33.0	33173	33114	−1978	+33817	47371
			1931	− 3 24.6	+45 30.9	33217	33158	−1976	+33820	47404
			1932	− 3 24.2	+45 32.1	33227	33169	−1972	+33854	47436
			1933	− 3 24.8	+45 31.4	33240	33181	−1979	+33853	47444
			1934	− 3 24.6	+45 30.9	33254	33195	−1978	+33858	47457
			1935	− 3 24.3	+45 31.5	33267	33208	−1976	+33881	47483
			1936	− 3 24.4	+45 31.8	33278	33219	−1977	+33900	47504
			1937	− 3 24.7	+45 32.2	33299	33240	−1982	+33928	47539
			1938	− 3 25.0	+45 31.7	33316	33256	−1985	+33937	47556
Dehra Dun	+30 19	78 03	1903	+ 2 41.6	+43 14	33430	33393	+1571	+31429	45884
			1904	+ 2 40.8	+43 18	33405	33368	+1562	+31479	45900
			1905	+ 2 39.9	+43 24.2	33383	33347	+1552	+31572	45948
			1906	+ 2 39.2	+43 29.8	33365	33329	+1545	+31625	45971
			1907	+ 2 38.2	+43 36.1	33324	33289	+1533	+31735	46017
			1908	+ 2 36.7	+43 42.2	33293	33258	+1517	+31819	46053
			1909	+ 2 34.8	+43 48.0	33276	33242	+1498	+31909	46103
			1910	+ 2 31.9	+43 54.8	33257	33225	+1469	+32019	46165
			1911	+ 2 29.2	+44 02.0	33238	33207	+1442	+32136	46233
			1912	+ 2 25.9	+44 08.9	33218	33188	+1409	+32244	46294
			1913	+ 2 22.2	+44 16.4	33191	33163	+1373	+32359	46355
			1914	+ 2 18.8	+44 22.9	33134[b]	33107[b]	+1337[b]	+32427[b]	46361[b]
			1915	+ 2 15.5	+44 30.6	33083	33057	+1304	+32522	46391
			1916	+ 2 11.0	+44 37.9	33050	33026	+1259	+32627	46442
			1917	+ 2 06.5	+44 44.1	33010	32988	+1214	+32704	46467
			1918	+ 2 01.4	+44 49.6	32980	32959	+1164	+32782	46501
			1919	+ 1 56.1	+44 54.8	32962	32943	+1113	+32863	46545
			1920	+ 1 52.0	+44 59.9	32951	32934	+1073	+32949	46598
			1921	+ 1 47.1	+45 04.2	32945	32929	+1026	+33025	46648
			1922	+ 1 43.2	+45 08.6	32927	32912	+ 988	+33091	46682
			1923	+ 1 38.6	+45 12.5	32927	32913	+ 944	+33167	46736
			1924	+ 1 34.6	+45 17.1	32940	32928	+ 906	+33270	46818
			1925	+ 1 30.5	+45 21.0	32948	32937	+ 867	+33353	46883
			1926	+ 1 26.3	+45 26.1	32933	32923	+ 827	+33436	46931
			1927	+ 1 22.1	+45 29.2	32931	32922	+ 786	+33494	46971
			1928	+ 1 18.5	+45 31.8	32940	32931	+ 752	+33554	47020
			1929	+ 1 15.5	+45 35.9	32946[c]	32938[c]	+ 724[c]	+33601[c]	47058[c]
			1930	+ 1 11.9	+45 34.5	32963	32956	+ 689	+33631	47091
			1931	+ 1 08.6	+45 35.9	33001	32994	+ 658	+33698	47166
			1932	+ 1 05.4	+45 37.3	33032	33026	+ 628	+33755	47228
			1933	+ 1 02.8	+45 38.2	33056	33050	+ 604	+33798	47275
			1934	+ 1 00.0	+45 39.0	33087	33082	+ 577	+33847	47333
			1935	+ 0 56.7	+45 39.3	33140	33135	+ 547	+33894	47403
			1936	+ 0 53.8	+45 40.3	33181	33177	+ 519	+33968	47485
			1937	+ 0 51.6	+45 39.9	33223	33219	+ 499	+34003	47539
Helwan	+29 52	31 20	1903[1]	− 3 21.4	+40 31.2	30209	30157	−1769	+25819	39739
			1904[1]	− 3 17.1	+40 34.3	30161	30111	−1728	+25825	39707
			1905[1]	− 3 12.7	+40 36.2	30159	30112	−1690	+25852	39723
			1906[1]	− 3 05.2	+40 38.4	30165	30121	−1624	....	.....

[a]Values 1908 through 1933 are as determined from those at Lukiapang which site was superseded in 1934 by Zô-sè and corrected to international magnetic standards (IMS) by the following relations for (Zô-sè −Lukiapang) = +10′.7 in D, +7′.7 in I, −89γ in H, −82γ in X, +109γ in Y, +62γ in Z, −18γ in F, where corrections on IMS adopted are +0′.1 in D, +37.4γ in H, and −0′.7 in I. [z]Five months, August to December, 1908. [a]Five months, June to September and December, 1928. [b]On basis of new value of moment of inertia and revised distribution-coefficients for magnetometer; on basis of old constants values in 1914 would have been 33165γ for H and +32458γ for Z. [c]Ten months, January to July and October to December, 1929.

(*To be continued in March, 1944, number*)

PREDICTIONS FOR THE COMING SUNSPOT-CYCLE

By W. Gleissberg

In view of the close relations between terrestrial magnetism and solar phenomena readers of the Journal will be interested in the fact that during recent years some progress has been made on the problem of sunspot-predictions. Methods for predicting sunspot-numbers have been developed by Waldmeier [see 1 of "Reference" at end of paper], by Stewart and his collaborators [2, 3], and by the present writer [4, 5]. While the methods of Waldmeier and of Stewart permit us only to predict the remaining course of the *current* spot-cycle from its initial course [6, 7], my method enables us to predict the behavior of the *coming* spot-cycle. Moreover, the probability of the predictions made by my method can be computed from the probability-laws of sunspot-variations [8]. It seems necessary to add calculations of probability to all predictions of sunspot-numbers because the irregularities of the spot-curve make predictions with complete certainty impossible.

Table 1 gives some results of the calculations on probability concerning the next spot-cycle which will begin very probably before 1945. In this Table R_M denotes the highest smoothed relative number of the next spot-cycle [9], t_r the time during which the smoothed relative numbers will rise from $(1/4)R_M$ to R_M, and t_f the time during which they will fall from R_M to $(1/4)R_M$. The probabilities for R_M and t_r have been taken from an earlier publication [10], those for t_f are published here for the first time.

Table 1—*Calculations of probability concerning the next sunspot-cycle*

Time of rising from $(1/4)R_M$ to R_M	Probability	Highest smoothed relative number	Probability	Time of falling from R_M to $(1/4)R_M$	Probability
$t_r<24$ months	0.57	$R_M>100$	0.98	$t_f>60$ months	0.97
$t_r<28$ months	0.73	$R_M>120$	0.95	$t_f>70$ months	0.91
$t_r<32$ months	0.91	$R_M>140$	0.89	$t_f>80$ months	0.73

As for all spot-cycles observed hitherto the average of R_M was 100 and the averages of t_r and t_f were 35 and 52 months, respectively, the data given in Table 1 show that the coming spot-cycle will probably be interesting by reason of its high maximum and of the rapid increase and slow decrease of spot-numbers.

References

[1] M. Waldmeier, Neue Eigenschaften der Sonnenfleckenkurve, Astr. Mitt., No. 133, 105-130 (1935).

[2] J. Q. Stewart and H. A. A. Panofsky, The mathematical characteristics of sunspot variations, Astroph. J., **88**, 385-407 (1938).

[3] J. Q. Stewart and F. C. Eggleston, The mathematical characteristics of sunspot variations—II, Astroph. J., **91**, 72-82 (1940).

[4] W. Gleissberg, The long-period fluctuations of the characteristics of sunspot cycles, Observatory, **63**, 215-218 (1940).

[5] W. Gleissberg, The prediction of sunspot numbers, Pub. Istanbul Univ. Obs., No. 14 (1941).
[6] M. Waldmeier, Prognose für das nächste Sonnenfleckenmaxium, Astr. Nach., No. 6208 (1936).
[7] J. Q. Stewart and F. C. Eggleston, A detailed prediction of the remaining course of the present sunspot cycle, Pub. Astr. Soc. Pacific, **52**, 379-382 (1940).
[8] W. Gleissberg, Probability laws of sunspot variations, Astroph. J., **96**, 234-238 (1942).
[9] The smoothed relative numbers of the cycles observed hitherto have been published by W. Brunner in Tables on sunspot frequency for 1749-1938, Terr. Mag., **44**, 247-256 (1939).
[10] W. Gleissberg, Prognose für den nächsten Sonnenfleckenzyklus, Pub. Istanbul Univ. Obs., No. 15 (1941).

University Observatory,
Bayazit, Istanbul, Turkey, June 11, 1943

LETTERS TO EDITOR

(See also page 214)

SOLAR AND MAGNETIC DATA, JULY TO SEPTEMBER, 1943, MOUNT WILSON OBSERVATORY

During the third quarter of 1943 the Earth's magnetic field was moderately disturbed. Although disturbances lasting several days occurred, only two were called storms.

TABLE 1—*Magnetic storms*

Greenwich civil time							Range in H
Beginning			Ending				
1943	*h*	*m*		*d*	*h*	*m*	γ
Aug. 8	3	..	Aug.	9	9	..	145
Aug. 28	10	..	Sep.	1	7	..	220

At the beginning of the storm of August 8-9, group No. 7599 was 17° east of the central meridian. During the storm of August 28-September 1, a small group of spots, 15° south, was observed on August 28 (35° west), 29, and 30 (65° west); no spots were seen on August 31 and September 1.

From September 26 to October 4 the horizontal intensity varied irregularly, the daily variations ranging from 140 gammas on September 30 to 60 gammas on October 4, with a daily average of 90 gammas for the nine days. The largest sunspot-group of the quarter, Mount Wilson No. 7617, large enough to be seen without a telescope, was crossing the solar disk from September 26 to October 9. This group, latitude 16° north, was in the same region where No. 7599 had been, a region which had been active since July 7.

Minimum sunspot-activity has not yet been reached. During the third quarter of 1943, 29 spot-groups were observed at Mount Wilson only two of which belonged to the new cycle.

TABLE 2—Solar and magnetic data

Day	July 1943						August 1943						September 1943					
	K_2						K_2						K_2					
	Whole disk	Central zone	$H\alpha$ bright	$H\alpha$ dark	No. groups	Mag'c char.	Whole disk	Central zone	$H\alpha$ bright	$H\alpha$ dark	No. groups	Mag'c char.	Whole disk	Central zone	$H\alpha$ bright	$H\alpha$ dark	No. groups	Mag'c char.
1	0	0	0	1	0	0	1	1	1	1	1	0.5	1	0	1	2	0	0.5
2	0	0	0	1	0	0	1	1	1	1	1	0.5	1	0	1	1	0	0.5
3	0	0	0	1	0	0.5	..	..	..	..	2	1	1	1	1	1	0	1
4	0	0	0	1	0	1	1	1	1	1	4	0.5	1	1	1	1	0	0.5
5	0	0	0	1	0	0.5	1	0	1	0	2	0.5	1	1	1	1	0	0.5
6	1	0	0	1	0	1	2	1	1	1	2	0.5	1	1	1	2	1[a]	0
7	1	1	1	1	1	0.5	1	1	1	1	2	0.5	1	1	1	1	1	0
8	1	1	1	1	2	0.5	1	2	1	1	3	1	1	0	1	2	1	0.5
9	1	1	1	2	3	0.5	1	1	1	1	3	0.5	1	1	1	1	1	0.5
10	2	1	2	2	2	0.5	1	1	1	1	2	0.5	1	0	1	2	2	1
11	1	2	2	3	2	0.5	1	1	2	1	2	0	1	1	1	2	2	0.5
12	2	2	2	3	1	0.5	1	1	2	2	2	0	1	1	1	2	2	0.5
13	2	2	2	3	2[f]	0.5	1	1	2	2	3	1	0	1	0	2	0	0.5
14	1	2	2	3	1	0	2	1	2	2	3	0.5	0	0	0	1	0	0.5
15	1	1	2	2	1	0	2	1	2	2	2	0.5	0	0	0	1	0	0
16	1	0	2	2	1	0	2	2	2	1	2	1	0	0	0	1	2	0
17	1	0	1	1	1	0	2	2	2	1	4	0.5	0	0	0	1	3	0.5
18	..	..	1	1	1	0.5	2	2	2	1	4	0.5	1	1	1	1	1	0
19	1	0	0	1	1	0.5	2	2	2	1	5	0.5	1	1	1	1	1	0.5
20	1	0	1	0	1	0	2	2	2	1	5	0.5	1	0	1	1	1	0
21	1	0	1	0	1	0	2	2	2	1	3	0.5	1	0	1	0	1	0.5
22	0	0	1	1	1	0.5	2	2	2	1	4	0	1	0	1	0	1	0.5
23	0	0	0	0	1	0	2	2	2	1	2	0	0	0	0	1	1	0
24	1	1	0	0	2	0	2	1	2	1	2	0.5	..	..	..	..	0	0
25	1	1	1	0	2	0	1	1	1	1	0	0.5	0	0	0	1	0	0.5
26	1	0	1	0	1	0	1	1	2	1	0	0.5	0	0	0	1	1	1
27	1	0	1	0	3	0	1	1	2	2	1	0	1	0	1	0	1	0.5
28	1	0	1[d]	1	3	0	1	1	1	1	1	1	1	0	1	1	1	1
29	1	0	1	0	2	0	1	1	2	2	1	1	1	0	1	1	1	1
30	1	0	1	1	2	0.5	1	1	2	2	1	1.5	1	1	1	1	1	1.5
31	1	1	1	1	1	0	1	1	2	2	0	2						
Mean	0.9	0.5	0.9	1.0	1.3	0.3	1.4	1.3	1.6	1.2	2.2	0.6	0.7	0.4	0.7	1.1	0.9	

NOTE—For an explanation of these tables see this JOURNAL, 35, 47-49 (1930).

The character-figures of solar phenomena are estimated from the spectroheliograms which are made with a 2-inch solar image, usually in the early morning. Very bright chromospheric eruptions are reported in these notes if observed at any time during the day.

[a, b]Formation of a new group which later developed to average size or larger; (a) less than 30° from the center of the disk, (b) more than 30° from the center of the disk.

[c, d]Very bright chromospheric eruptions; (c) less than 30° from the center of the disk, (d) more than 30° from the center of the di·k.

[e, f, g, h, i, j, k, l] Passage of a large or active group across the central meridian within 5°, 10°, 15°, 20°, 25°, 30°, 35°, 40° of the center of the disk, respectively.

CARNEGIE INSTITUTION OF WASHINGTON,
MOUNT WILSON OBSERVATORY.

SETH B. NICHOLSON

PRINCIPAL MAGNETIC STORMS

Sitka Magnetic Observatory

July to September, 1943

(*Latitude 57° 03'.0 N., longitude 135° 20'.1 or $9^h\ 01^m.3$ W. of Gr.*)

July 3—Gradually increasing deviations from normal preceded by half a day a briefly severe disturbance occurring between 04^h and 09^h GMT, July 3, during which was recorded a range of 730 gammas in H.

August 7-9—A small increasing bay in D beginning at $06^h\ 25^m$ GMT, August 7, developed into sharp decreases in all elements during the fourth three-hour period of the day when a K-index of 7 was recorded on D and Z. A quiet interval occurred between 17^h, August 7, and 02^h, August 8, followed by seven hours of slight disturbance leading into seven hours of large-amplitude oscillations yielding K-indices of 8. By 23^h, August 8, H- and Z-traces had returned to near normal position but sharp peaks occurred in H between $02^h\ 00^m$ and $02^h\ 18^m$, and between $03^h\ 32^m$ and $03^h\ 48^m$ again giving a K-index of 8. The traces continued to be somewhat disturbed for several hours.

August 13-20—A rather severe disturbance may be said to have had its beginning at $01^h\ 34^m$ GMT, August 13, although at that time the variations were slight and not until 08^h did large oscillations begin which at $10^h\ 40^m$ evidenced a superposing of small rapid oscillations lasting about three hours. During this time a K-index of 8 occurred. Minor disturbances continued until a brief flare-up during the first eight hours of August 17 again recorded a K-index of 8. This was followed by similarly brief periods of severe activity on three successive nights each reaching its maximum intensity at about 10^h with K-indices of 9, 7, and 8, respectively.

August 28-September 4—Commencing suddenly just after 10^h GMT, August 28, with sharp decreases in all elements, a protracted period of magnetic activity brought the most severe storm in two years. Activity was moderate until 02^h, August 30, when a gradually increasing development gave K-indices of 9 and 8 between 09^h and 15^h, subsided somewhat until $01^h\ 52^m$, August 31, when the storm entered its major stage with such rapid movement of the traces that they could not be followed without recourse to the insensitive magnetogram. K-indices of 7, 8, 9, 8, 9, 7 were recorded during this period. Moderate activity continued through September 4 with a more severe interval from $06^h\ 45^m$ to 16^h, September 3.

September 26-30—Beginning gradually about 03^h GMT, September 26, a disturbance somewhat less severe than the preceding one continued through the end of the month. Motion of the traces was not particularly rapid until the major phase was reached at about 10^h, September 29, when the recording of D became intermittent. Again between 11^h and 12^h, September 30, D was characterized by exceptionally rapid oscillations but of small magnitude, while at the same time a K-index of 9 was being recorded on H. Intensity of the storm appeared to be diminishing at the end of the quarter.

Harold W. Pinckney, *Observer-in-Charge*

Cheltenham Magnetic Observatory

July to September, 1943

(Latitude 38° 44'.0 N., longitude 76° 50'.5 or $5^h\ 07^m.4$ W. of Gr.)

July 4-6—A moderate disturbance yielding two *K*-indices of 6 began at about 12^h GMT, July 4, and lasted approximately forty-eight hours. Intermittent minor activity continued for more than a week.

August 8-9—A moderately severe storm resulting in a *K*-index of 7, two indices of 6, and five indices of 5, began indefinitely at about 03^h GMT, August 8, and ended at about 07^h, August 9. The total departure from the normal values of the elements was not greater than is indicated by the *K*-indices.

August 12-14—A moderate disturbance began very indefinitely at about 20^h GMT, August 12, and continued until about 02^h, August 14. Seven *K*-indices of 5 were recorded.

August 16-17—Minor activity continued after the storm of August 12-14. During the third three-hour period of August 16 and the first three-hour period of August 17, large bays in declination resulted in *K*-indices of 6.

August 19-21—Another increase in activity began during the last three-hour period of August 19, resulting in a *K*-index of 6 for the first period of August 20. The activity became unimportant at about 13^h GMT, August 20, but increased again four hours later and continued until about 07^h, August 21.

August 28-29—An unimportant storm began at about 11^h GMT, August 28, and apparently ended at about 24^h, August 29, but was followed within a few hours by a much greater storm.

August 30-September 1—This was the severest storm recorded here in a number of months. It began at $01^h\ 42^m$ GMT, August 30. During the three hours immediately following all three elements underwent large changes, resulting in two *K*-indices of 6. From 05^h to 20^h the activity was only moderate. The severest part of the storm came between 21^h, August 30, and 15^h, August 31. The *K*-indices during this period were 7, 7, 8, 6, 6, 6. The storm can be considered to have ended at about 03^h, September 1, but moderate activity continued for a number of days.

September 8-11—A period of moderate disturbance lasting several days began indefinitely at about 17^h GMT, September 8. The time of ending is largely a matter of opinion, but one such opinion would place it near 06^h, September 11. Five *K*-indices of 5 and one of 6 were recorded.

September 26-October 4—A prolonged period of minor disturbance which sometimes approached the magnitude of a storm, began at 03^h GMT, September 26, and continued until about 12^h, October 4. Eight *K*-indices of 6 and nineteen of 5 were scattered through the period.

John Hershberger, *Observer-in-Charge*

Tucson Magnetic Observatory

July to Septemer, 1943

(*Latitude 32° 14′.8 N., longitude 110° 50′.1 or 7h 23m.3 W. of Gr.*)

July 4-6—Following several hours of slight activity a moderately severe storm began suddenly at 09h 54m GMT, July 4, with an increase of 40 gammas in *H*. Except for some short-period activity superimposed on the longer-period variations, there was no outstanding characteristic of the storm. The major disturbance ended late in the Greenwich day July 6. Ranges: *D*, 17′.5; *H*, 143 gammas; *Z*, 39 gammas.

August 8-9—A moderate storm began about 02h GMT, August 8. There was considerable activity in *D* and *H*, with a notably decreased *H* for about sixteen hours beginning at 16h 30m, August 8. The storm ended about 09h, August 9. Ranges: *D*, 17′; *H*, 176 gammas; *Z*, 56 gammas.

August 12-14—The moderate storm, which began about 21h GMT, August 12, seemed to have more than the usual amount of activity of fairly short period. The storm ended about 24h, August 14. Ranges: *D*, 14′.5; *H*, 146 gammas.

August 16-17—A moderate storm, characterized chiefly by several long-period swings in *D* and *H*, began about 00h GMT, August 16, and ended about 09h, August 17. Ranges: *D*, 18′; *H*, 124 gammas.

August 18—A very brief storm began gradually at 01h GMT, August 18, and continued for only about thirteen hours. The unusual features of the disturbance were two very rapid increases of 34 gammas in *H*, one beginning at 07h 24m and another at 09h 00m. The hours following the storm were very quiet.

August 19-21—A mild storm began about 06h GMT, August 19. The ranges were not large, and there was no outstanding characteristic. The disturbance ended about 07h, August 21. Ranges: *D*, 13′; *H*, 133 gammas.

August 28-September 4—A storm or series of storms lasting a full week began about 10h GMT, August 28. There was some short-period activity for the first fifteen hours, followed by irregular variations in *D* and *H*. The initial period of moderate intensity led to increased activity at 02h, August 30. From 20h, August 30, to 16h, August 31, the disturbance was severe, with large swings in *D* and *H* and some activity in *Z*. The intensity then was variable from very mild to moderate, ending about the middle of the Greenwich day September 4. Ranges: *D*, 33′; *H*, 234 gammas (212 gammas within one hour); *Z*, 57 gammas.

September 8-11—A moderate storm began at 17h GMT, September 8, with a small bay in *H* and noticeable short-period activity for the first eight hours. Some variations in *D* and *H* and slight disturbance of *Z* continued until the end of the storm, about 05h, September 11. Ranges: *D*, 16′.5; *H*, 110 gammas.

September 27-October 1—A relatively long-period of disturbance, probably including more than one storm, began about 00h GMT, September 27, without sharp commencement. Moderately severe storm-conditions prevailed from 23h, September 27, to 09h, September 28, and from 00h, September 30, to 05h, October 1. The other periods of the storm were characterized by irregular variations of *D* and *H* without unusually prominent maxima and minima. The disturbed conditions were still in effect as of the date of this report (October 1).

J. H. Nelson, *Observer-in-Charge*

Huancayo Magnetic Observatory

July to September, 1943

(*Latitude 12° 02′.7 S., longitude 76° 20′.4 or $5^h\ 01^m.4$ W. of Gr.*)

August 28-31—Several days of moderate magnetic disturbance began at about 4.5^h GMT, August 28, with irregular changes in the *H*-trace which developed to a sharp maximum at 08^h and a deep minimum at $10^h\ 12^m$, with a range of 251 gammas between the two, but no other marked large changes before quieting down again at about 19^h. There was only very mild disturbance for two days until the late hours of August 30, when a series of slow deep bays and moderately high peaks began with a minimum at $01^h\ 47^m$. At about 08^h the disturbance quieted down until $11^h.5$. Thereafter a series of moderate peaks and bays were encountered until about 21^h. There was only a slight decrease in *H*-values after the storm and *D* and *Z* showed mildly marked variations only during the daylight hours of August 28 and 31.

Paul G. Ledig, *Observer-in-Charge*

Watheroo Magnetic Observatory

July to September, 1943

(*Latitude 30° 19′.1 S., longitude 115° 52′.6 or $7^h\ 43^m.5$ E. of Gr.*)

August 7-9—A small magnetic disturbance began with a sudden commencement in *H* at $08^h\ 20^m$ GMT, August 7, with small but very rapid oscillations in all three elements. The traces were relatively quiet until $06^h\ 55^m$, August 8, when larger fluctuations began without any special features except between 15^h and 16^h, August 8, when large bays and peaks appeared in all three elements. Between 21^h, August 8, and 10^h, August 9, the value of *H* was considerably below normal, but the traces then resumed their usual quiet values. Ranges: *D*, 20′.1; *H*, 124 gammas; *Z*, 124 gammas.

August 13-21—During the period 04^h GMT, August 13, to 15^h, August 21, the traces were more than usually disturbed although no special period can be assigned as a major disturbance. However, the following special features may be mentioned: On August 16 at 08^h there was a large bay in *H;* on August 18 during the period from 09^h to 11^h there were large fluctuations in all three elements. Range in *D* was approximately 26′.

August 28-September 1—A period of disturbance which began at about Greenwich noon, August 28, gradually developed during the period August 28-30 and culminated in major disturbance on August 31. There were no features of special interest during the first three days except that between 02^h and 08^h, August 30, there were rapid fluctuations in all three elements and imposed on the *H*-trace was a large bay between 02^h and 05^h. At $01^h\ 43^m$, August 31, there was a sudden small movement which might be considered as a sudden commencement and thereafter the movements became large and sweeping, the maximum period of activity being between 12^h and 14^h. The traces gradually quieted down after 17^h, August 31, and apart from moderate bays and peaks between 12^h and 13^h, September 1, the disturbance subsided by 19^h, September 1. Ranges: *D*, 25′; *H*, 140 gammas; *Z*, 173 gammas.

W. C. Parkinson, *Observer-in-Charge*

NOTES

23. *Halley Lecture of May 28, 1943*—It was the privilege of the Editor to publish the first draft of Professor Chapman's Halley Lecture in the last issue of the JOURNAL. There was not time, however, to submit the proof to Professor Chapman before the dead-line set by the postal authorities. We have now received the proof with certain additions which appeared in the final draft as published in *Nature* of August 28, 1943.

The first addition is a poem pertaining to the unknown inventor of the compass, as translated by Mrs. Chapman. It was inserted just before the section entitled "The magnet and the compass" on page 133 of the September number of the JOURNAL. It is as follows [Occasional Notes of R. Astron. Soc., No. 9 (1941)]:

> Him who first taught with magnetism to imbue
> The iron: and the ocean's watery waves
> Made clear to ships erst doubting: him who linked
> Shores, till his time far sundered, and by wind
> Brought mutual products to remotest lands
> A thankless day, a heedless age have hid.
> No mighty name survives him, being dead.
> Hope not to wrest thy fame from Stygean shades
> Nor seek to win thy ashes honors due.
> And yet—to know within thy secret heart,
> A skill surpassing common mortals, to have blessed
> The life of far-off grandsons, is not this
> Itself the Elysian fields, the shining crown?

At the end of the lecture the following paragraph was added:

"A non-magnetic ship was built for the ocean magnetic survey; unfortunately this was lost by fire in 1929. Later the British Admiralty built another non-magnetic ship, the *Research*, which should by now have completed its first voyage had war not intervened. We may hope that when peace returns the great work which Halley so well began will be taken up again with his own vigor."

Errata are to be noted as follows: Page 134, for "p. 6" in footnote * read "§"; page 136, in last line for "little needles" read "lines of the little needles"; page 139, tenth line of first paragraph, for "that" read "than"; page 140, first line of second last paragraph, for "than" read "then"; page 141, sixth line of last paragraph, for "there" read "their"; page 143, change footnote * to read "*See Occasional Notes of the Royal Astronomical Society, No. 9 (1941)."

24. *Aurora, radio fade-out, and magnetic storm of August 28-31, 1943*—Dr. H. T. Stetson reports that an abrupt fade-out on Station WWV 5-Mc signals was observed at Needham, Massachusetts, August 28, 1943, from $01^h 40^m$ to $13^h 00^m$ (eastern war time), coincident with the sudden appearance of a small group of sunspots which had just passed the Sun's meridian. This group lasted somewhat more than 24 hours before its

dissolution. An aurora was reported in Maine on the evening of August 29 and at Needham and the Blue Hill Observatory a very brilliant aurora was observed throughout the night of August 30-31. A suspicion of the auroral arch appeared on the evening of August 31. Dr. Stetson states that the fade-out of August 28 is consistent with a sudden ultra-violet ionization on the side of the Earth toward the Sun coincident with the sudden outburst of solar activity observed. The appearance of the aurora on the nights of August 29 and 30 is consistent with his earlier findings of a 24- to 36-hour lag in the arrival of a particle-radiation from the Sun. Station WBBM 780-Kc signals faded out in the latter half of the night of August 30. The WWV 5-Mc record showed irregular disturbances in the F-layer but no fade-out, as though the primary effect had been due to the penetration of slow-moving particles to the E-layer altitude.

This fade-out and auroral display coincided with the initial phase of a magnetic disturbance which reached its maximum intensity in the night of August 30-31, with K-index 8 at Cheltenham, Maryland.

R. G. Ferris, Applied Physics Laboratory of the Johns Hopkins University, reports that he observed marked auroral display at Spicer, Minnesota, at about midnight August 29 (05^h GMT, August 30). The display consisted of a large illuminated area covering the portion of the sky from the northeast to the southwest and extending almost to the zenith. The intensity was greatest at either end. It had clear white color. It was noted that in traveling a distance of some miles that the edge of the illuminated area did not shift with respect to stars and hence the conclusion is tentatively offered that this aurora was quite high in the sky. At one stage of the display a huge spiral of a character similar to a big twisted rope appeared in the sky in the handle of the Big Dipper.

25. *Soviet Cosmic-Ray Expedition to Mount Ararat*—We learn from *Science* that the Soviet Academy of Sciences recently sent an expedition headed by Professor Alikhanyan, a Stalin prize winner, to the summit of Mount Ararat to study cosmic rays. The group spent several weeks on Mount Ararat last year and collected valuable data on cosmic rays. These materials were the subject of study during the winter by experts of the Physico-Technical Institute of the Academy of Sciences. It is reported that in the composition of the cosmic rays a considerable quantity of protons, nuclei of hydrogen atoms, was discovered, the exact nature of which has not yet been investigated. The further examination of this question is one of the most important tasks of the present expedition.

26. *Cosmic-ray Expedition of the University of Chicago*—Dr. Marcel Schein, in charge of a cosmic-ray expedition of the University of Chicago, left Chicago on August 17, 1943, for six weeks of work at the Mount Evans (Colorado) Laboratory maintained cooperatively by the University of Denver, the Massachusetts Institute of Technology, and the University of Chicago. The party is studying the formation and distribution of mesotrons and electron-showers. In addition to Dr. Schein, the group included Anatole Rogencki, Fellow of the Rockefeller Foundation; Lloyd Lewis and Julius Tabin, graduate students of physics and Miss Jane Hoover, student in the Department of Physics at the University; Miss Joan Hinton, graduate student at the University of Wisconsin, and Mrs. Lewis.

27. *Hermanus Observatory*—Director Ogg of the Hermanus Observatory calls attention to a typographical error in the latitude of the Magnetic Observatory of the University of Cape Town on page 6 of that Observatory's publication "Magnetic Results 1933-1936." The sentence should read "Latitude 33° 37′ S" instead of "Latitude 30° 37′ S." It is of interest to note that most of the recording at the Hermanus Observatory is now done with the Askania variometers which have been made twice as sensitive as the la Cour variometers. The latter are kept in reserve for use when making adjustments and for large magnetic storms.

28. *Magnetic surveys in South and North America*—The magnetic-field party of the United States Coast and Geodetic Survey that has been operating in South America for nearly a year has returned to the United States. Magnetic observations were made in every Republic. The program was primarily one of repeat-observations, but several new stations were established near airports in Brazil. Comparison-observations were made at the Huancayo Magnetic Observatory in Peru, the Pilar Magnetic Observatory in Argentina, and the Vassouras Magnetic Observatory in Brazil.

It has been learned that an observer of the Instituto Geográfico Militar occupied about 50 declination-stations in Uruguay. Another party established five good magnetic stations along the coast of Uruguay using an Askania magnetometer. At all of the latter stations diurnal-variation observations were made over a three- or four-day period.

Two field parties of the Coast and Geodetic Survey who had been making repeat-observations in the eastern half of the United States, closed their season's work early in November, 1943.

29. *Personalia*—We regret to record the death of Captain *F. O. Creagh-Osborne*, C. B., formerly director of the Compass Department of the Admiralty, on September 1, 1943, aged seventy-six.

We regret to record the death of Dr. *F. J. W. Whipple*, formerly superintendent of the Kew Observatory, September 25, 1943, at the age of sixty-seven.

We regret to record the sudden death in September, 1943, of Mr. *Ayres* who, since March, 1943, has been in charge of the magnetic program at the Apia Observatory, Western Samoa. Considerable difficulty is encountered in maintaining the full program of work at the Observatory because of the paucity of trained personnel.

We regret to record the death on November 1, 1943, at the age of 80 years, of Dr. *Alexander G. McAdie* who, from 1913 to 1931, was Professor of Meteorology at Harvard University and for 18 years Director of the Blue Hill Observatory, Milton, Massachusetts. Dr. McAdie was much interested in atmospheric electricity and published several papers on that subject.

LIST OF RECENT PUBLICATIONS

By H. D. Harradon

A—Terrestrial and Cosmical Magnetism

Bartels, J. Der magnetische Charakter des Jahres 1941. Terr. Mag., **48**, No. 3, 167-169 (1943).

Chapman, S. On magnetism in the Sun's atmosphere. Mon. Not. R. Astr. Soc., **103**, No. 2, 117-130 (1943). [Presidential address before the Royal Astronomical Society, April 9, 1943.]

Edmond Halley and geomagnetism. Nature, **152**, 231-237 (Aug. 28, 1943). [Halley Lecture delivered at Oxford, May 28, 1943.]

Edmond Halley and geomagnetism. Terr. Mag., **48**, No. 3, 131-144 (1943). [First draft of Halley Lecture.]

Dubief, J. Resultats des mesures magnétiques au Sahara. Alger, Trav. Inst. Mét. et Phys. Globe de l'Algérie. No. 1, 1-15 (1943). [Contains results of magnetic measurements at 85 stations made from October 1940 to December 1942, together with brief descriptions of the stations.]

Fleming, J. A. The Sun and the Earth's magnetic field. Smithsonian Inst. Rep. 1942, 173-208, 19 pls. (1943). [The eleventh Arthur lecture given under the auspices of the Smithsonian Institution, February 26, 1942.]

Fleming, J. A., and W. E. Scott. List of geomagnetic observatories and thesaurus of values—II. Terr. Mag., **48**, No. 3, 171-182 (1943).

Harradon, H. D. Some early contributions to the history of geomagnetism—IV. The letter of Georg Hartmann to Duke Albrecht of Prussia. Terr. Mag., **48**, No. 3, 127-130 (1943).

Johnston, H. F. American magnetic character-figure, C_A, three-hour-range indices, K, and mean K-indices, K_A, for April to June, 1943. Terr. Mag., **48**, No. 3, 163-166 (1943).

Knapp, D. G., and H. H. Howe. Magnetic observatory results at Tucson, Arizona, for 1931-32. Washington, D. C., U. S. Coast Geod. Surv., 118 pp. (1942). 25 cm.

Magnetic observatory results at Honolulu, Hawaii, for 1933-34. Washington, D. C., U. S. Coast Geod. Surv., 114 pp. (1943). 25 cm.

Kutscher, F. Erdmagnetische Versuchsmessungen auf Kieslagerstätten im südlichen Riesengebirge. Beitr. angew. Geophysik, **9**, Heft 2, 187-197 (1941).

Principal Magnetic Storms. Principal magnetic storms, April to June, 1943. Terr. Mag., **48**, No. 3, 188-190 (1943).

Puzicha, K. Der Magnetismus der Gesteine als Funktion ihres Magnetit-Gehaltes. Beitr. angew. Geophysik, **9**, 158-187 (1941).

Reich, H. Ueber die natürliche Magnetisierung von Gesteinen auf Grund von Messungen an Bohrkernen. Beitr. angew. Geophysik, **9**, 40-64 (1941).

Wasserfall, K. F. Periodic changes in $\triangle D$ at Oslo, 1843-1930. Terr. Mag., **48**, No. 3, 145-150 (1943).

Three-hour-range index, K, at Dombås Observatory during 1939 to 1942. Terr. Mag., **48**, No. 3, 151-160 (1943).

Woollard, G. P. Transcontinental gravitational and magnetic profile of North America and its relation to geologic structure. Bull. Geol. Soc. Amer., **54**, 747-790 with 9 pls. and 6 figs. (1943). [The results of this traverse indicate that the majority of the smaller gravitational anomaly areas appear to have a magnetic counterpart except in areas of surface magnetic control and that in general the magnetic anomalies can best be related to the lithology of either the surface volcanics or the underlying crystallines. One notable exception appears to be the high over Permian sediments in western Pennsylvania.]

Geologic correlation of areal gravitational and magnetic studies in New Jersey and vicinity. Bull. Geol. Soc. Amer., **54**, 791-818 with 5 pls. and 2 figs. (1943). [The results of these investigations from the magnetic viewpoint are summed up by the author as follows: (1) The regional magnetic anomaly pattern shows primarily a reflection of surface and near-surface rocks of high magnetic susceptibility, principally the Triassic diabase sheets, gabbro, serpentine, and the magnetite mineral-

ized areas in the pre-Cambrian. (2) The detailed magnetic survey shows the effect of variations in lithology with little reflection of basement configuration or structural control. (3) The results of the detailed surveys show that the degree to which geologic variations in structure and lithology are reflected varies with the density and magnetic susceptibility changes and that every area is a separate problem.]

B—Terrestrial and Cosmical Electricity

BOBROVNIKOFF, N. T. Aurora Borealis of August 30-31, 1943. Pop. Astr., **51**, No. 8, 438 (1943).

DICKEY, P. A. Natural potentials in sedimentary rocks. Amer. Inst. Min. Metall. Eng., Tech. Pub. No. 1625, 10 pp. (1943).

GINSBURG, V. L. Polarization of the lines in the night-sky luminescence spectrum and in the spectrum of northern lights. Moscou, C.-R. Acad. sci., **38**, No. 8, 237-240 (1943).

GÖTZ, F. W. P., UND F. SCHMID. Höhenmessung des Nordlichts vom 18. September 1941. Verh. Schweiz. Naturf. Ges., Sitten 1942, pp. 88-90.

HAMILTON, J., W. HEITLER, AND H. W. PENG. Theory of cosmic-ray mesons. Phys. Rev., **64**, Nos. 3 and 4, 78-94 (1943).

HARPER, J. L. Resistivity method of locating oil and gas pays. Oil and Gas J., **41**, No. 5, 64-66 (1942).

JÁNOSSY, L., AND G. D. ROCHESTER. Barometer effect of penetrating cosmic-ray showers. Nature, **152**, 445 (Oct. 16, 1943).

Penetrating non-ionizing cosmic rays. Proc. R. Soc., A, **181**, No. 987, 399-408 (1943). [An account is given of experiments proving the existence of a penetrating non-ionizing component of cosmic radiation at sea-level. It is shown that the radiation has a mean range of approximately 10 cm in lead, and is probably the same as the penetrating non-ionizing radiation discovered by Rossi and Regener in experiments at 4300 m above sea-level. An argument is brought forward indicating that the radiation might consist of neutrons.]

LAPP, R. E. Note on large cosmic-ray bursts in an unshielded ionization chamber. Phys. Rev., **64**, Nos. 5 and 6, 129-130 (1943).

MOUNCE, W. D., AND W. M. RUST. Natural potentials in well logging. Amer. Inst. Min. Metall. Eng., Tech. Pub. No. 1626, 6 pp. (1943).

C—Miscellaneous

APPLETON, E. V. Exploring the ionosphere: progress over a complete eleven-year cycle. Wireless World, **49**, No. 6, 182-183 (1943).

BRUNNER, W. Final relative sunspot-numbers for 1942. Terr. Mag., **48**, No. 3, 161-162 (1943).

Provisional sunspot-numbers for February and March, 1943. Terr. Mag., **48**, No. 3, 170 (1943).

BULLARD, E. C. The Earth's gravitational field. Endeavour, London, **2**, No. 7, 105-108 (1943).

CLOUGH, H. W. The long-period variations in the length of the 11-year solar period, and concurrent variations in terrestrial phenomena. Bull. Amer. Met. Soc., **24**, No. 4, 154-163 (1943).

FRENCH, H. M. Astronomy and amateur radio. Q S T, West Hartford, Conn., **27**, No. 11, 17-20 (1943). [Solar radiation and the ionosphere; sunspots; astrophysical measurements.]

GEOPHYSICS. The professional training of geophysicists. Report of Geophysics Education Committee of Metal Industry Education Division, A. I. M. E. Amer. Inst. Min. Metall. Eng., Tech. Pub. No. 1633, 19 pp. (1943).

GLEISSBERG, W. Die Höhe der nächsten Sonnenfleckenmaxima. Zs. Astroph., **21**, Heft 5, 347-349 (1942).

GÖTZ, F. W. P. Photographie des ultravioletten Sonnenspektralendes. Zs. angew. Photographie, **4**, Heft 5, 65-67 (1942).

Harradon, H. D. George Washington Littlehales, 1860-1943. Terr. Mag., **48**, No. 3, 183-184 (1943).

List of recent publications. Terr. Mag., **48**, No. 3, 193-196 (1943).

Healy, J. Boron in hot springs at Tokaanu, Lake Taupo. N. Z. J. Sci. Tech., Wellington, **24**, No. 1B, 1B-17B (1942). [In connection with the field-work described in this article, a magnetic survey of the Tokaanu area was made. A series of 100 observations of vertical intensity was made over a strip extending from a mile northwest to three miles southeast of the township using a Schmidt vertical magnetometer of the Askania type. The results indicated that in the vicinity of the thermal activity, there are areas of low magnetic intensity. The article is accompanied by a map showing magnetic anomalies and thermal activity in the vicinity of Tokaanu.]

Herroun, E. F. A comparison of the magnetic properties of solid and powdered magnetites: with observations on coercive force. Proc. Phys. Soc., **55**, No. 310, 338-343 (1943).

Khastgir, S. R., and Md. I. Ali. Investigations on atmospherics in high-frequency channels. Indian J. Phys., **16**, Pt. 6, 399-419 (1942).

Mount Wilson Observatory. Summary of Mount Wilson magnetic observations of sunspots for May and June, and July and August, 1943. Pub. Astr. Soc. Pacific, **55**, 200-201, 247-248 (1943).

New Zealand. Seventeenth annual report of the Department of Scientific and Industrial Research. Wellington, E. V. Paul, Govt. Printer, 44 pp. (1943). 34 cm. [This report covers the year 1941-42, and contains a report on the Magnetic Observatory, Christchurch, and the magnetic resurvey of New Zealand, by H. F. Baird, p. 43.]

Nicholson, S. B., and E. S. Mulders. Solar and magnetic data, April to June, 1943, Mount Wilson Observatory. Terr. Mag., **48**, No. 3, 186-187 (1943).

Nikolsky, K. On the theory of mesons. Moscou, C.-R. Acad. sci., **38**, No. 5-6, 173-175 (1943).

Rao, M. R. Measurement of the angle of arrival of down-coming waves from Indian regional short-wave stations. Indian J. Phys., **16**, Pt. 6, 347-367 (1942). [Results of the measurements of down-coming angles carried out at Delhi on signals radiated from the Bombay and Madras broadcasting stations of All-India Radio are given and discussed. Close agreement has been found between the experimental and the theoretical values. Use of pulse signals radiated from these stations made it possible to resolve the downcoming waves into their component waves and to determine the downcoming angles of each. The results provide an interesting study of the importance of the various parameters which may control propagation under given conditions. The role of the intervening ionized strata such as the *E*-layer is also analyzed and discussed.]

Swann, W. F. G. The variation of mesotron intensity with altitude and latitude, together with allied phenomena, and the bearing of these matters on the nature of the primary particles. Part II. J. Frank. Inst., **236**, No. 2, 111-139 (1943).

Waldmeier, M. Koronaintensität und Erdmagnetismus. Zs. Astroph., **21**, Heft 5, 275-285 (1942). [In Erweiterung früherer Untersuchungen wird auf die sogenannten *C*-Gebiete der Korona hingewiesen, die sich durch verstärkte Linienemission bemerkbar machen, und es wird sehr wahrscheinlich gemacht, dass diese Gebiete mit den aus erdmagnetischen Untersuchungen postulierten *M*-Gebieten, die bisher auf der Sonne selbst noch nicht festgestellt werden konnten und welche die Quellgebiete der korpuskularen Sonnenstrahlung darstellen, indentisch sind.]

Beobachtungen der Korona vor, während und nach der totalen Sonnenfinsternis vom 21. September 1941. Zs. Astroph., **21**, Heft 4, 181-193 (1942).

Photometrie der inneren Korona. Zs. Astroph., **22**, Heft 1, 18-29 (1942).

Sonnenaktivität, Ionosphäre und Erdmagnetismus. Scientia, Milano, **37**, 1-8 (1943). [In diesem Bericht werden einige in den letzten Jahren entdeckte Wirkungen von charakteristischen solaren Vorgängen und Erscheinungen auf die Ionosphäre, den Kurzwellenverkehr und den Erdmagnetismus mitgeteilt. Diese auf der Erde in den verschiedensten Formen beobachteten Wirkungen werden auf zwei Arten von der Sonne auf die Erder übertragen: durch kurzwelliges, ionisierendes ultraviolettes Licht und durch korpuskulare Strahlung.]

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